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AN INVESTIGATION OF THE GROWTH OF SCIENTIFIC
KNOWLEDGE AND CONCEPTS THROUGH THE
JUNIOR HIGH SCHOOL GRADES

A DISSERTATION

SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR
THE DEGREE OF BACHELOR OF EDUCATION

COLLEGE OF EDUCATION

BY

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CALGARY, ALBERTA.

May, 1941.

Thesis
1941
#40



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CHAPTER I

PURPOSE AND METHOD OF THE INVESTIGATION

This investigation was undertaken on the suggestion of Dr. M. E. LaZerte, Principal of the College of Education, University of Alberta. The suggestion was that a study be made of the growth in scientific knowledge and concept by pupils through the Junior High School Grades. So far as I am aware this project had not been previously attempted by anyone in this Province.

The investigation was carried on in Hillhurst Junior High School, Calgary, Alberta. There are ten classes in this School consisting of: three Grade 9 classes, four Grade 8 classes and three Grade 7 classes. For the sake of convenience they will be designated as: 9A, 9B, 9C, 8A, 8B, 8C, 8D, 7A, 7B, and 7C. My own class was 8D, so I used it as a Test discussion group, hence they did not write the Tests. This meant that three grade 9's, three grade 8's, and three grade 7's wrote on the Tests provided.

These Tests were specifically designed to measure pupil ability in certain definite areas of the scientific field. For example, Test I was to measure pupil achievement in Science Vocabulary; Test II was to measure the amount of Scientific Factual Knowledge possessed by the pupils; Test III was to measure ability in Understanding and Applying Scientific Principles; and Test IV was to measure the ability of pupils to think scientifically or reflectively.

CHAPTER II

PREPARATION OF THE TESTS

The first task in the preparation of the Tests was to compile lists of scientific words, facts and principles common to the Junior High School Grades. For this purpose a thorough study was made of the following sources and lists were compiled from them.

- (a) Alberta Intermediate Course of Study.
- (b) Calgary School Board Science Outline for Grades Seven and Eight.
- (c) Our Environment by Carpenter and Wood Books, I, II and III.
- (d) General Science by Limpus and Shore.
- (e) Experiences in General Science by Bowers and Sheane.
- (f) Survey of Science by Powers, Neumer and Bruner, Books I, II and III.

Test I was then built up around common science words as found in these different books or courses of study. It was prepared so as to contain eighteen words common to the grade 7, eighteen common to the grade 8 and eighteen common to the grade 9 level. Hence a total score of 54 could be obtained on this Test.

Certain definite principles such as the following were used in the preparation of the Tests:

- (a) Objective type questions were used in so far as advisable so as to overcome large errors in scoring and so as to cover as large a field as possible.
- (b) Various types of questions were used so as to help eliminate chance errors which would be more prevalent if only one type of question were used.
- (c) An attempt was made to include only those words, facts or principles, for any certain grade, which would probably be discussed before the Test was administered. (This was not always possible).
- (d) Questions for the different grades were scattered about promiscuously through the Test, but an attempt was made

to place an equal number of points for each grade in each section of the Test.

(e) "Yes", "No" questions were favored instead of the "True", "False" type because they do not place the wrong statement in front of the child as a fact.

Test II was set up in a similar manner to that of Test I with four sections to the Test having a total score of 54. There were eighteen parts specifically designed for each grade.

Test III was set up in a different fashion since it was felt advisable that for the most part pupils should have to rely upon their own resources and scientific knowledge without any suggestion as to the correct answer. Although there are not 54 questions, some of the questions are valued at two marks so that the total is 54 as in Test I and II. From the Key, page 16, it will be easily seen how the marks were distributed and that an even number were assigned to each grade's work.

The ideas incorporated in Test IV were chiefly taken from the book entitled "Science in General Education" - a report of the Committee on the Function of Science in General Education. This Test will be explained more fully later.

Tests I, II and III follow immediately along with their Keys for marking.

Test IScience Vocabulary Test

Write down, on foolscap, the numbers from 1 to 15 and after each write the word or words which correctly complete the following sentences:

1. For heating purposes in science experiments we use a----
2. Distance north or south of the equator is spoken of as----
3. All things which have weight and occupy space are known as--
4. The belief that breaking a mirror causes bad luck is called a----
5. The word ----- designates the brightest star in a constellation.
6. The word ----- applies to these scientific beliefs founded on study but not yet proven.
7. The name ----- is given to the path of a planet about the sun.
8. All of those things about us which affect our lives we call--
9. The tendency of a moving object to continue moving in a straight line is known as ----
10. An instrument used to see bacteria is called a ----
11. The fall ----- usually comes on September 21.
12. The ----- are the small openings in the leaves of plants through which they breathe.
13. The ----- is another name for air.
14. The moisture in the air is spoken of as the ----
15. A recording barometer is called a ----

Write down the numbers from 16 to 50 on foolscap and after each write the words "yes" or "no" according to what you think is correct, for each sentence. Do not guess.

16. Is a graduate used for measuring liquids?
17. Is Vega a very bright star?
18. Is asbestos organic matter?
19. Does sedimentation mean a form of settling?
20. Is the zenith overhead?
21. Are molecules larger than atoms?

22. If you are immune to a disease are you apt to contract it?
23. Does the earth revolve on its axis?
24. Does a running train possess kinetic energy?
25. Does chlorination mean purifying water by filtering it?
26. Is a cyclone usually a destructive wind?
27. Would you say that lead was a malleable substance?
28. Are stratified rocks formed by water?
29. Is osmosis the process by which plants absorb moisture through their roots?
30. Will an alkali turn litmus paper red?

Write down the numbers from 31 to 40 and after each put the letter of the correct answer for that question.

38. Water is said to be the universal solvent because:

(a) it dissolves many substances (c) it is a liquid
 (b) it will dissolve all substances (d) it melts easily

39. Spontaneous combustion is usually due to:

(a) rapid oxidation (c) carelessness with gasoline
 (b) decaying material (d) misuse of explosives

40. An instrument used to measure the humidity of the air:

(a) barometer (c) hydrometer
 (b) hygrometer (d) thermometer

Write down on your foolscap the numbers from 41 to 54 and after each number write the letter of the group of words in the second column which best matches with that number:

41. igneous	(a) suited to both land and water
42. Ursa Major	(b) an imprint in rock
43. amphibian	(c) breathing tube openings
44. fossil	(d) fire formed
45. solstice	(e) the atmosphere next the earth
46. spiracles	(f) the time of shortest days
47. trachea	(g) a constellation
48. feet-pound	(h) measuring work
49. troposphere	(i) the moon
50. Stalactites	(j) the purification of water
51. inclination	(k) breathing tubes
52. convection	(l) limestone caves
53. Aerotion	(m) the tilt of the earth
54. satellite	(n) air currents

Key to Test I

Question	Answer	Question	Answer
1 Bunsen Burner or spirit lamp		31	a
2 Latitude		32	b
3 Matter		33	d
4 Superstition		34	c
5 Alpha		35	c
6 Theory		36	a
7 Orbit		37	c
8 Our environment		38	a
9 Inertia		39	b
10 Microscope		40	b
11 Equinox			
12 Stomata or stoma		41	d
13 Atmosphere		42	g
14 Humidity		43	a
15 Barograph		44	b
		45	f
16 Yes		46	c
17 Yes		47	k
18 No		48	h
19 Yes		49	e
20 Yes		50	l
21 Yes		51	m
22 No		52	n
23 No		53	j
24 Yes		54	i
25 No			
26 No			
27 Yes			
28 Yes			
29 Yes			
30 No			

Test IIScience Knowledge Test

Write down the numbers from 1 to 15 on foolscap and answer each question with the word "yes" or "no" as you believe to be correct. Do not guess.

1. Is there any air in ordinary water?
2. Is Ursa Minor the astronomical name for the Big Dipper?
3. Is a nutcracker a first class lever?
4. Can we always depend upon our senses?
5. Do sunspots affect our earth?
6. Do air brakes on trains set by compressed air?
7. Does air take up space?
8. Does a meteorite strike the earth?
9. Does a boy do work when he plays football?
10. Does an airplane rise because it is lighter than air?
11. Does the wind ever blow on the moon?
12. Is a meat grinder a form of inclined plane?
13. Did Robert Fulton make the first steam ship?
14. Is a light year a measure of distance?
15. Is inertia always a hindrance to work?

Write down the numbers from 16 to 50 on your foolscap and after each write the word or words which best complete the sentence of that number.

16. Water covers approximately ----- of the earth's surface.
17. A cyclone is a ----- pressure area.
18. The man to make the first mercury barometer was -----
19. The idea of vaccination was first developed by -----
20. The fourth planet from the sun is -----
21. Water pressure depends entirely upon the --- of the water.
22. Sounding balloons are usually filled with ----- gas
23. Meteors are visable because they are heated by friction with the -----
24. A general property of matter is -----
25. About ----- percent of the air is oxygen
26. The seasons are due to the ----- of the earth on its axis.

27. A single ----- pulley will give a mechanical advantage of two.

28. The gas which turns limewater milky is -----

29. The earth turns from ----- to -----

30. A magnifying glass makes things appear larger because it--- the light.

Write down the numbers from 31 to 42 and after each put the letter of the correct answer for that question.

31. A match is called a fire-ladder because:

(a) it has several parts to it	(c) it lights by stages
(b) it has different materials	(d) it is made from in it
	wood

32. The solar system is composed of:

(a) six major bodies	(c) nine major bodies
(b) ten major bodies	(d) three major bodies

33. A good example of non-matter would be:

(a) light	(c) hydrogen
(b) air	(d) wood

34. When water freezes its volume:

(a) decreases	(c) compresses
(b) remains the same	(d) increases

35. Reliable weather forecasts can be based upon:

(a) the color of the sky at sunset	(c) barometric readings
(b) the almanac	(d) changes in the moon

36. A third class lever is:

(a) a pair of scissors	(c) a can opener
(b) a lemon squeezer	(d) a baseball bat

37. An instrument used to measure earthquake shocks is called a:

(a) seismograph	(c) spectroscope
(b) Stethoscope	(d) heliograph

38. The boiling point of pure water at sea level is:

(a) 112 degrees C.	(c) 180 degrees F.
(b) 212 degrees F.	(d) 212 degrees C.

Key to Test II

Question	Answer	Question	Answer
1	Yes	31	c
2	No	32	b
3	No	33	a
4	No	34	d
5	Yes	35	c
6	No	36	d
7	Yes	37	a
8	Yes	38	b
9	Yes	39	c
10	No	40	b
11	No	41	c
12	Yes	42	a
13	Yes		
14	Yes	43	g
15	No	44	f
		45	h
16	2/3 to 3/4	46	e
17	Low	47	i
18	Torricelli	48	d
19	Jenner	49	j
20	Mars	50	c
21	Depth	51	k
22	Hydrogen	52	b
23	Air or Atmosphere	53	l
24	Weight - Inertia or Occupies space	54	a
25	20 or 21		
26	Tilt or Inclination		
27	Movable		
28	Carbon dioxide		
29	West - East		
30	Refracts or bends		

TEST 111A TEST OF SCIENTIFIC PRINCIPLES AND THEIR APPLICATION

Write down the numbers on your foolscap from 1 to 12. Read each question over carefully and also the suggested answers. There may be one or more correct answers to each question.

Write down the letter or letters of the correct parts after alue the right number. Do not guess.

1 1. An aeroplane rises because:

(a) it is lighter than air (c) the air pressure is greater under the wing than above it

(b) it goes so fast (d) the propeller pulls it up

2 2. We have a leap year every four years because:

(a) that year is longer than the others
 (b) it takes a little less than a year for the earth to revolve about the sun
 (c) it takes a little more than a year for the earth to revolve about the sun
 (d) a year is really 365-1/4 days

1 3. When you spill gasoline on your hands it makes them cold because:

(a) the gasoline is cold (c) the air is cold
 (b) as it evaporates it (d) gasoline is like water
 absorbs heat

2 4. We should not leave growing plants in our bedrooms at night because:

(a) they tend to make the air impure (c) the plants will not do well
 (b) their perfume is not good (d) they breathe oxygen and give off carbon dioxide for us

1 5. If you hang a heavy weight by a long thin string and then start the weight swinging it will gradually swing crooked and always in the same way because:

(a) The earth turns on its axis (c) The earth's magnetism attracts it
 (b) the moon attracts it (d) the wind affects it

2 6. If a balloon is fastened over the neck of a Florence flask and then the flask is heated the balloon fills up because:
(a) heated air rises (c) warm air is lighter than
(b) air expands when heated (d) heat increases the speed of
the molecules and they move
farther apart

1 7. There is no soil on the moon because:
(a) the rocks have not had (c) the moon has no air or water
time to turn to soil on it
(b) there are no people there (d) there are no plants there

2 8. The moon does not always appear the same to us because:
(a) its shape changes (c) it revolves about the earth
(b) sometimes the sun shines (d) the lighted surface is not
on more of it than at other always toward the earth
times

1 9. The thickness of a dam depends upon:
(a) the amount of water it (c) the length of the dam
is to hold
(b) the height of water to be (d) the distance that the
held water is to be backed up

2 10. Plants do not do well in a dark room because:
(a) light helps them to grow (c) they get too damp
(b) heat helps them to grow (d) they can only make food
in sunlight

2 11. The trade winds blow toward the equator because:
(a) they blow from north and (c) the earth turns around
south
(b) warm air rises and cool (d) it is cooler north and
air pushes in to take its south of the equator
place

2 12. In the process of oxidation:
(a) a flame is always (c) carbon dioxide is always
produced produced
(b) oxygen is always produced (d) heat is always produced

Write a short explanation of each of the following statements.

Be sure to tell exactly why each one is true and if there is more than one reason be sure to include the others.

Value

- 1 13. A balloon filled with hydrogen rises because-----
- 2 14. The wind often blows from the sea to the land in the afternoon because-----
- 2 15. When telephone wires are strung in summer they are always left loose because-----
- 2 16. Carbon dioxide is a good fire extinguisher because-----
- 2 17. Eggs have to be boiled longer on mountain tops than near sea level in order to cook them the same amount because---
- 1 18. The shadow of a tree always resembles the shape of the tree because-----
- 2 19. The ocean is getting saltier each year because-----
- 1 20. If it were not for the sun we could not see the moon because-----
- 1 21. In order to brighten up a room it should be painted in light colors because-----
- 1 22. When you rub a match on a rough surface it lights because--
- 1 23. A falling barometer is apt to mean a storm because-----
- 2 24. A long handled wrench is better than a short handled one to loosen a rusty bolt because-----
- 1 25. Scientists tell us that without dust particles in the air we would have no rain. Explain.
- 1 26. Although the earth is nearer the sun in winter than in summer yet it is colder. Explain.
- 1 27. A lift pump will not pump water out of a well over thirty feet deep. Explain.
- 2 28. A pitcher of cold water will often become moist on the outside. Explain.
- 1 29. An eclipse of the moon always occurs at the full moon. Explain.
- 2 30. Although grass appears green to us it really isn't that color at all. Explain.

Value

2 31. We are told that the Dead Sea is so salty that a person can easily float in the water. Explain.

1 32. In a thunder storm it is not wise to sit under a tall tree. Explain.

1 33. If you drop a magnet it may weaken it. Explain.

1 34. If your clothes catch on fire it is a good idea to roll up in a rug or a blanket. Explain.

2 35. Although Vancouver is not much further south than Calgary yet its climate in winter is much milder than ours. Explain.

2 36. By blowing on a watch glass filled with warm ether you can freeze it to a wet cork. Explain.

Key to Test III

Score	Question	Answer	Score	Question	Answer
1	1	c	1	7	c
2	2	c d	2	8	c d
1	3	b	1	9	b
2	4	a d	2	10	a d
1	5	a	2	11	b d
2	6	b d	2	12	c d

For question 13 to 36 inclusive the following scores were given for the ideas as shown by the Key. Exact wording was not expected, of course. Where the score was 2 for two parts a score of 1 was assigned if one idea was correct.

Score

1 13 hydrogen is lighter than air.

2 14 land warms more quickly than water- heated air is displaced by the cool air from the sea.

2 15 cold causes the wires to contract- in winter they would snap if not left loose.

2 16 it will not support combustion- it is heavy so excludes the air.

2 17 the air pressure is less- the boiling point is lowered.

1 18 light travels in straight lines.

2 19 rivers are continually carrying salt or minerals to the sea- evaporation leaves the minerals behind.

1 20 we see the moon by reflected sunlight.

1 21 they reflect more light than do dark colors.

1 22 friction causes enough heat to ignite it.

1 23 air moves into a low pressure zone carrying the storm with it.

2 24 the force arm is greater giving greater leverage, a greater mechanical advantage is procured.

1 25 This is because the water vapor must have a nucleus about which to collect.

Score

1 26 This is because, in the northern hemisphere the sun's rays strike at a greater slant in winter.

1 27 This is because the lift pump depends on air pressure which is only great enough to lift water that high.

2 28 This is because cool air cannot hold as much moisture as warm air. Hence when the cool jar cools the air about it the moisture condenses on the jar.

1 29 This is because when the moon is full the earth is between it and the sun.

2 30 This is because the grass absorbs all of the colors in sunlight except green. The green is reflected.

2 31 This is because when salt is dissolved in water it makes the water heavier. There is so much salt in the dead sea that the water is heavier than a person's body.

1 32 This is because lightning usually strikes tall objects through which it can pass to the ground.

1 33 This is because when a magnet is dropped the jar disturbs the alignment of the molecules.

1 34 This is because the rug excludes the air so the flame is smothered.

2 35 This is because Vancouver is much nearer a large body of water. Also because of its low altitude.

2 36 This is because the blowing causes the ether to evaporate rapidly. This evaporation causes sufficient cooling to freeze the water under the watch glass.

Test IV

This was the most difficult Test to prepare and to mark because when we attempt to test and evaluate attitudes then the work becomes exceedingly intricate. It was felt that scientific thinking comprises many aspects, some of which might be stated as follows: the ability to discover and define problems, the ability to observe accurately, the ability to select facts relevant to a problem, the ability to collect and organize facts, the ability to draw inferences from given facts or data, and the ability to see cause and effect relationships.

As previously stated, the problems in this Test were based upon problems found in the Chapter on Reflective Thinking in Science from the publication Science in General Education- a Report of the Committee on the Functions of Science in General Education. This Committee was set up by the Progressive Education Association.

Question 1 was designed to test the ability of pupils to recognize cause and effect relationships. Question 2 was a test of their ability to select facts relevant to a problem. Question 3 was to test their ability to discover and define problems. Question 4 was designed to discover their ability to draw inferences from given facts. Question 5 was a test of the ability of pupils to draw conclusions while questions 6 and 7 had to do with ability to plan a suitable scientific procedure.

Another problem which made this Test difficult to prepare was that of selecting material with which the pupils were not already familiar. The Test, as it was finally used, follows immediately, along with the Key according to which it was scored.

TEST OF SCIENTIFIC ATTITUDES AND REFLECTIVE THINKING

1. You will notice that in each of the following statements, two events are mentioned. These events (1) may both result from the same cause, (2) one may be the cause of the other, (3) there may only be some relation between them, or (4) there may be no relation between them at all. Write down the letters from (b) to (p) and after each letter put number 1, 2, 3, or 4, as you think is correct for that statement.

Example:

We went on a picnic - a rain storm came.

Since there is no relation between going on a picnic and the rain coming, your answer for this one would be written:

(a) - 4

(b) The branches of a tree sway to and fro - a nearby windmill turns.

(c) A woman dropped a dish - the dish broke.

(d) A can of fruit was opened - the fruit was found to be spoiled.

(e) Our alarm clock stopped - the next morning father was late for work.

(f) A man drove his car down town - another car ran into him.

(g) John is the brightest boy in school - he is also the tallest.

(h) A big snowstorm came - the children were late next day.

(i) The lights went out - the radio also went off.

(j) Our brother was late for dinner - the dessert was ice cream.

(k) The wind was blowing - the door opened.

(1) A fire engine went down the street - a police car was seen to follow later.

(m) The school filled with smoke - the fire alarm rang.

(n) We heard a dog bark in the night - next morning our spare tire was gone.

(o) It was Thursday morning - we were late for school.

(p) - The streets were icy so there were many car accidents, several people fell and were hurt.

2. A farmer had a large flock of chickens. He noticed that on some days he would get very few eggs from the chickens, while on other days he would get very many.

Write down the letters of the following suggestions which you consider it would be necessary to know in order to help the farmer settle this problem.

(a) The number of chickens.

(b) The weather conditions from day to day.

(c) The kind of food used from day to day.

(d) The kind of chickens.

(e) The age of the chickens.

(f) The size of the eggs.

(g) If the flock had any disease.

(h) The color of the chickens.

(i) The time they went to roost.

(j) The time the eggs were gathered each day.

3. It is a common superstition that if a hog is killed at the time of month when the moon is full, the bacon will shrivel up more than if the hog is killed at some other time. Pick out the three best steps from the following nine and write down their letters in a row, in the order in which you would perform them if you were setting out to disprove this superstition.

(a) Fry the bacon from the different hogs at different times and over different fires.

(b) Kill one hog at the full of the moon.

(c) Take only one hog.

(d) Take several hogs of the same kind.

(e) Kill one hog at the full moon and others at different times of the month.

(f) Fry the bacon any length of time and in different pans.

(g) Take several hogs of different kinds.

(h) Kill all the hogs at the time of the full moon.

(i) Fry the bacon from the different hogs in similar pans and over the same fire.

4. In an experiment some starch was treated with iodine and a blue color resulted. Later some white bread, some potato, some meat and some cheese were treated with iodine, and the bread and potato turned blue, while the cheese and meat did not. Write down the letters of the following conclusions which would be reasonable to infer from this experiment.

(a) Bread is better food than meat.

(b) Meat has no starch in it.

(c) Potatoes and bread are starchy foods.

(d) If the meat had been white it would have probably turned blue.

(e) Cheese contains more vitamins than bread.

(f) Bread and meat are the same kind of food.

(g) Cheese is easily starched.

(h) Cheese and potato are different kinds of food.

(i) Meat is easily starched.

(j) Cheese and meat are the same kind of food.

5. Write down conclusions for one of the following observations:

(a) The place of a house is usually the coldest part.

(b) Ice bubbles float in the ocean in winter.

- (c) Water puts out fire.
- (d) Blowing on fire makes it burn better.
- (e) After milk has stood for a while the cream is found at the top.
- (f) If water is allowed to freeze in a jug, it is not to break the jug.
- (g) Heavy oil is often put on the street car tracks at the turns.
- (h) In order to cook potatoes by boiling them, on a mountain top, salt is added to the water.

6. Suppose you have been given the problem of finding out by experiment which is the heavier, nickel or silver. Carefully outline the procedure which you would follow in order to solve this problem.

7. Many people believe that the weather is apt to change with a change in the moon. Explain how you would go about to find out for yourself whether this is a fact, or a superstition.

Key to Test IV

Score	Question	Answer	Score	Question	Answer
15	1 - b	1	5	2	a,b,c,g,j
	c	2			Score=R-W
	d	4	6	3	d,e,i(best)
	e	2			g,h,a(fair)
	f	3			b,c,f,j(wrong)
	g	4			Score= 2 for
	h	2			best -,1 for
	i	1			fair and minus
	j	4			1 for each
	k	3			wrong answer,
	l	4	4	4	b,c,h,i
	m	1			Score=R-W
	n	3			
	o	4			
	p	1			

8 5 - a - Warm air rises - or its equivalent.
 b - Air is lighter than CO_2 - "
 c - Does not support combustion - Cools the material below kindling temperature.
 d - The moving air carries oxygen to the flame-
 e - Cream is lighter than milk-
 f - Water expands as it freezes -
 g - This is to overcome friction or wear -
 h - To raise the boiling point -

4 6 - Points were given for these ideas- Procure pure material, use same size of each, weigh each carefully, compare the weights.

4 7 - Points were given (1 for each) for these ideas or similar ones- Keep a record of the changes of the moon, also keep a record of the changes in the weather, compare these records, do this for several weeks.

CHAPTER III

ADMINISTRATION AND MARKING OF TESTS

Administration of Tests -

Before each Test was administered it was discussed orally with grade 8D in order to obtain pupil reactions to each question and to the Test in general. It was found that some questions were ambiguous, either because the directions were not clear, or because they were capable of more than one answer. Such errors as were brought to light by these discussions were eliminated, in so far as possible.

Each of the other nine classes wrote the Test and each class was given approximately the same amount of time. (I say approximately, because the buzzers in Hillhurst School do not ring automatically, and even after allowing a few minutes to spare some classes were cut short of time. This was especially true of 7C while writing Test IV.).

The same instructions, oral and written, were given to each class and no questions were answered except those pertaining to errors in printing or of such a nature. However, care was taken to see that each child knew how to proceed.

The time set for each Test was as follows:

Test I	28 min.
Test II	28 min.
Test III	35 min.
Test IV	35 min.

Each Test was administered to all classes on the same day whenever this was possible. A period of about two weeks was allowed between the various Tests so that they would not become too tedious for the pupils. Test IV was given first because it called for no previous instruction whereas the other three did. This Test was given about October 20, 1910. The others were administered in January and February.

The pupils were told the purpose of the Test, and

appeared to keep interested. They seemed to look upon the Tests as a kind of growth-chart which would tell them just how much they grew in scientific knowledge and understanding from grade to grade.

Marking of Tests -

The Tests were made of the objective type chiefly and marked according to keys as previously shown. This was done in the hope of eliminating subjective errors of marking which would otherwise tend to invalidate results. Tests I and II were easily scored objectively so these scores are probably more reliable than those of Tests III and IV since a portion of each of these Tests called for ideas, which are always more difficult to score than just facts or words, even though a key is used.

No half marks were given so whenever the answer was in doubt no score was allowed for that part of the Test. By referring to the Keys on pages 7, 11, 16, 23, the method of scoring each question can easily be ascertained.

Test IV was scored and tabulated question by question because the various questions tested various phases of the scientific concept. This was also done because some classes found this Test too long for the time allotted. This was especially true of the grade 7 classes.

The tabulation of scores follows and can easily be understood from the headings. The School Average is the average mark (not percent) of each child's achievement in science in his regular school work. The grade 7 averages will not be reliable since their time in Junior High School has not been sufficient to grade their performance at all accurately. However, the grade 8 and 9 averages should be a much more reliable criterion or score of what is expected of a Junior High School pupil in science.

TABLE I

	Score Test I	Score Test II	Score Test III	Score Test IV	Total Score	School Average
Agate, Ruth	26	30	20	26	102	104
Anderson, Dorothy	13	13	21	20	67	91
Areno, Walter	27	17	23	23	90	84
Armstrong, Nelson	33	41	37	26	137	126
Boyd, Sarah	33	21	20	15	89	105
Brewis, Rachel	26	25	20	22	93	78
Carter, Mervyn	31	25	30	15	101	104
Campbell, Colin	40	44	36	28	148	134
Cove, Jack	30	26	31	23	110	102
Dowsett, Hilda	35	30	26	16	107	95
Dowling, Mildred	23	20	19	30	92	89
Fox, Margaret	17	15	14	13	59	71
Fair, Jack	42	42	36	24	144	119
Gee, Norma	43	38	30	24	135	121
Gibson, Olive	14	24	18	24	80	64
Hall, Marguerite	21	24	25	27	97	89
Hatfield, Bruce	41	43	36	22	142	123
Hewitt, Catherine	24	18	15	24	81	72
Ingham, Hazel	25	23	23	21	92	81
Johnson, Ken	29	33	32	25	119	110
Jenkins, Bill	34	10	23	26	93	79
La Rue, Eugene	31	28	29	27	115	105
Matthews, John	26	33	26	33	118	112
Miller, Jim	42	34	29	27	132	118
Morrison, Gerry	40	31	35	29	135	124
Mitchell, Irma	22	21	20	11	74	94
Meldon, Carol	27	26	21	25	99	89
McNab, Gladys	29	33	32	28	112	98
Nielson, Dorothy	31	30	29	26	116	117
Pearson, Betty	22	23	25	24	94	101
Patton, Bud	33	26	37	26	122	98

Class IX A (continued)

	Score Test I	Score Test II	Score Test III	Score Test IV	Total Score	School Average
Roe, Bernard	37	33	24	21	115	100
Steadman, Stanley	41	41	41	22	145	98
Strang, John	23	20	19	25	87	81
Strang, Marjorie	14	25	22	11	72	81
Starrat, Gordon	32	23	23	21	99	87
Talbot, Betty	25	18	18	14	75	89
Timmons, Dorothy	32	25	27	22	106	103
Tisdall, Jean	29	28	29	28	114	102
Tuwinniaid, Edwin	20	10	23	18	71	65
Wells, Gordon	41	39	41	27	148	127
Willis, Melvin	30	33	35	24	122	97
	1234	1142	1120	963	4459	4127

Class IX B

	Score Test I	Score Test II	Score Test III	Score Test IV	Total Score	School Average
Ashley, Irene	25	21	21	20	87	72
Bancroft, Donald	34	40	26	31	131	115
Beatty, Alex	22	31	33	22	108	89
Birchall, Margaret	17	32	28	30	107	83
Brailey, Ella	25	18	20	24	87	90
Brand, Laura	29	35	19	21	104	96
Brandon, Marjorie	12	19	11	19	61	48
Browning, Charles	30	37	29	24	120	114
Campbell, Irene	9	26	11	7	53	71
Clifford, Marian	22	21	23	22	88	90
Cooper, George	30	31	33	20	114	102
Davis, William	35	36	34	29	134	109
Dowling, Dorne	28	32	31	29	120	110
Faunt, Robert	34	36	33	24	127	113
Fitzsimmons, Wesley	21	37	31	28	117	113
Gardiner, Laurene	22	17	21	18	78	86
Garner, Mona	31	25	25	22	103	98
Hunter, Margaret	18	23	12	19	72	59
Johnstone, George	25	22	20	14	81	96
Jones, Marjorie	33	40	35	33	141	123
Kraft, Frances	24	32	30	25	111	102
Lamb, Marguerite	16	12	21	23	72	91
Mann, Donald	36	32	29	29	126	114
Martin, Elmer	20	27	26	11	84	74
McPhee, Jean	21	19	22	17	79	92
Munroe, Genevieve	27	14	11	22	74	64
Newinger, Donald	29	32	26	26	113	92
Parnell, Fred	20	29	28	23	100	109
Roberts, Charles	35	35	28	31	129	118
Zouter, Frances	24	26	26	28	104	98
Staples, Shirley	16	29	34	25	104	121

Class IX B (continued)

	Score Test	Score Test	Score Test	Score Test	Total Score	School Average
Stephens, Kenneth	1 35	11 37	111 26	1V 26	124	113
Strange, Dorothy	21	32	20	21	94	97
Underhill, Catherine	29	28	26	26	109	109
Wallace, Alexander	22	31	25	14	93	84
West, Derek	29	32	30	28	119	108
Williams, Eileen	24	25	15	22	86	86
Young, Mildred	25	31	30	32	118	122
	955	1082	949	895	3881	3671

Class IX C

	Score Test I	Score Test II	Score Test III	Score Test IV	Total Score	School Average
Campbell, Dorothy	24	20	16	19	79	79
Cawsey, Audrey	32	34	29	28	123	110
Cozzubbo, Margaret	26	25	14	13	78	86
Craig, Kenneth	30	34	23	23	110	90
Daniel, Robert	28	33	29	15	105	104
Delay, Frank	25	24	23	19	91	104
Geddes, Kenneth	35	37	26	28	126	109
Godlonton, Pearl	26	34	22	26	108	82
Guthrie, Ruby	30	27	31	27	115	106
Hallberg, Margaret	32	27	30	26	115	110
Hambrook, Mary	21	28	27	22	98	109
Harvey, Elsie	29	18	15	18	80	85
Hendry, Evelyn	28	24	20	34	106	110
Hess, Louise	21	20	23	22	86	97
Hopkins, Marian	14	10	13	25	62	71
Jordan, Marie	19	30	23	28	100	93
Kerslake, Thelma	26	24	20	25	95	89
Lawson, Barbara	23	23	21	23	90	102
Lee, Peggy	19	38	27	26	110	105
Leighton, Rita	17	19	14	27	77	62
Lumley, Doris	25	24	20	18	87	104
Martin, Jim	35	35	27	27	124	102
Marston, Allan	31	34	32	27	124	101
McMurray, Dave	10	36	32	15	93	98
Meikle, Donald	18	21	23	17	79	70
Nielson, Cecil	22	31	33	25	111	87
O'Neill, Margaret	31	22	20	20	93	89
Riley, Leonard	24	39	34	29	126	109
Robertson, Noreen	13	17	12	15	57	67
Rose, Jack	37	32	26	21	116	104
Schroeder, Dorothea	34	32	22	20	108	102
Shantz, Patty	22	24	24	23	93	99

Class IX C

	Score Test <u>I</u>	Score Test <u>II</u>	Score Test <u>III</u>	Score Test <u>IV</u>	Total Score	School Avg
Stuckey, William	33	34	23	26	116	109
Talerio, Pat	17	13	15	11	56	47
Upton, Gordon	40	35	32	25	132	97
Urquhart, Robert	28	39	31	23	121	118
Wait, Yvonne	11	15	19	23	68	55
Ware, Roy	26	24	23	23	96	115
Williams, Erskine	39	40	35	29	143	126
Winchester, Alice	34	31	26	23	114	102
Woodrow, Lloyd	32	35	23	16	111	96
	1972	1142	978	930	4122	4349

Class VIII A

	Score Test I	Score Test II	Score Test III	Score Test IV	Total Score	School Average
Anderson, Olive	34	35	24	34	127	103
Applegate, Barry	20	27	26	27	100	98
Bull, Douglas	11	23	17	8	59	77
Campbell, Evelyn	36	29	24	18	107	81
Chisolm, James	19	21	23	26	89	89
Christie, Shirley	7	12	10	18	47	61
Church, Audrey	22	17	17	13	69	60
Clarke, Robert	27	31	19	26	103	95
Cook, Jean	17	21	12	15	65	71
Doten, Verne	16	25	22	22	85	80
Forzani, Bart	16	4	6	9	35	48
Gardner, Donald	14	12	12	9	47	65
Goodwin, James	38	32	21	24	115	101
Haworth, John	12	17	15	15	59	72
Johnson, Wallace	21	17	16	13	67	75
King, Marie	15	7	12	10	44	64
Knight, Marie	12	17	16	13	58	59
Long, Roberta	11	15	15	9	50	69
Matthew, Peter	19	29	23	24	95	96
Morrice, Jean	39	35	23	18	115	97
Myra, Berna	13	24	20	17	74	81
Parder, Ruth Evelyn	22	16	14	20	72	60
Pierce, Hazel	17	22	17	25	81	81
Rees, Cynthia	10	17	17	23	65	73
Robb, Gordon	35	31	27	27	120	101
Shantz, Helen	15	18	17	11	61	90
Somerville, Thos.	10	17	18	12	57	64
Staley, Howard	18	29	21	18	86	86

Class VIII A

	Score Test 1	Score Test 11	Score Test 111	Score Test 1V	Total Score	School Average
Taylor, Duncan	37	43	34	30	144	103
Thompson, Donna	20	24	15	14	73	85
Ulrich, Joyce	28	27	23	25	103	100
Ward, Mary	29	18	23	25	95	90
Wilmott, Lois	36	30	27	24	117	94
Young, Lorraine	24	31	19	30	104	93
	720	773	645	638	2776	2762

	Score Test I	Score Test II	Score Test III	Score Test IV	Total Score	School Average
Aikenhead, Donald	25	33	20	30	108	100
Baker, Frances	26	18	10	14	68	87
Baker, Horace	21	21	19	16	77	82
Broughton, Irene	5	23	9	14	51	63
Collison, Lawrence	34	31	25	24	114	94
Davis, Rosetta	38	30	20	17	105	86
Dingle, Donald	25	30	29	21	105	97
Edwards, Margaret	23	27	20	28	98	85
Ellison, John	22	22	27	21	92	90
Gilbert, Joyce	10	8	15	22	55	82
Goddard, Norna	10	23	17	24	74	73
Goudy, Norna	21	19	17	23	80	77
Hamilton, Alice	29	20	19	17	85	87
Hooks, Shirley	24	33	23	29	99	99
Kraft, Norman	13	19	16	10	58	80
Larkan, Tom	12	21	14	10	57	79
Lindseth, Joyce	22	31	23	32	108	95
Lyons, Muriel	17	19	12	18	66	65
McCulloch, Jack	14	19	18	14	65	77
McLellan, Marguerite	10	17	16	22	65	61
McReynolds, Ann	27	27	19	23	96	76
McTier, Joan	20	25	18	21	84	85
Mathews, Violet	11	18	21	14	64	74
Montalbetti, Earl	28	30	23	24	105	89
Newborn, Ronald	14	22	19	15	70	70
Nicholson, Willard	9	27	24	19	79	68
Pecover, Jack	31	38	29	25	123	100
Peebles, Corrine	16	21	14	18	69	83
Postlewite, M.	15	15	19	22	71	69
Proctor, William	22	22	21	15	80	82
Roe, Richard	23	27	20	20	90	89
Ryder, Jessie	31	38	24	25	118	89
Sager, Joe	9	16	15	9	49	62
Stewart, Margaret	25	15	17	18	75	87
Tregillus, Marian	20	22	17	16	75	78

	Score Test 1	Score Test 11	Score Test 111	Score Test 1V	Total Score	School Average
Abernethy, Bill	21	22	20	20	83	91
Appleby, Mary	8	15	13	16	52	59
Armstrong, Mirriam	13	13	15	27	68	73
Atkinson, Jim	21	28	22	21	92	101
Barnes, Aileen	12	14	20	15	61	71
Cozzubo, Hazel	14	20	14	13	61	70
Davis, Joan	8	10	20	21	59	61
D'Eath, Bob	15	29	19	27	90	82
Draper, Barbara	31	32	19	26	108	101
Ferrie, Betty	15	24	13	16	68	84
Frazer, Jim	31	30	20	24	105	92
Gee, Dick	23	25	17	25	90	75
Hamilton, Wilson	26	25	20	27	98	77
Holman, Linda	15	23	19	22	79	83
Kinder, Margaret	4	17	14	12	47	82
Jones, Eunice	3	9	16	14	42	67
Lambly, Norman	31	30	23	30	114	101
Leighton, Charlie	22	27	21	15	85	78
Long, Stella	16	20	19	23	78	83
Lott, Norma	19	25	15	15	74	82
Lyons, Dorothy	10	8	9	13	40	63
Mannen, Delight	11	14	12	13	50	74
Murray, Hubert	24	30	17	23	94	79
McCullough, Joyce	16	17	19	21	73	72
Nichols, Beverly	16	20	16	22	74	74
Stark, Barbara	11	21	19	17	68	81
Stickney, Jim	14	16	17	18	65	70
Stockdale, Don	21	33	20	26	80	86
Symons, Doreen	12	16	17	21	66	86
Tewksbury, Aurora	32	28	18	28	106	90
Wallace, Shirley	6	11	12	12	41	62
Wilson, John	16	26	23	21	86	80
	537	678	558	644	2417	2530

Class VII A

	Score Test 1	Score Test 11	Score Test 111	Score Test 1V	Total Score	School Average
Alger, Grant	15	24	19	20	78	58
Beazley, Shirley	14	14	12	19	59	69
Beeby, Vivian	11	12	8	20	51	57
Bell, Gordon	26	30	17	29	102	79
Benson, Gladys	7	11	12	22	52	56
Burrows, Bill	6	23	13	20	62	49
Cook, Paul	6	10	12	8	36	43
Delaine, Joyce	13	18	13	16	60	60
Desson, Mary	5	17	14	4	40	49
Frost, Ken	15	15	14	19	63	61
Girling, Roy	10	28	20	20	78	72
Hallberg, Lawrie	4	22	15	15	56	51
Hatfield, Bob	21	29	18	25	93	68
Henderson, Eileen	11	12	12	18	53	65
Hepple, Jacqueline	4	14	10	13	41	43
Hornby, George	12	20	11	12	55	37
Lienweber, Murray	17	12	13	8	50	50
Love, Walter	12	24	15	20	71	50
Malin, Joyce	10	11	14	18	53	49
Martin, Doug	6	16	12	15	49	55
McIver, Stan	16	22	12	19	69	52
Moore, Mirian	8	7	8	8	31	45
Moore, Don	14	22	15	17	68	67
Munroe, Barbara	5	15	16	9	45	61
Nevard, Eileen	7	21	9	18	55	37
Orchard, James	13	19	20	14	66	63
Poffenroth, Henry	4	19	14	16	53	55
Roberts, Gordon	15	26	17	19	77	57
Robinson, Rose	11	17	11	16	55	58
Ritchie, Gordon	10	21	10	14	55	62
Salway, Billie	9	16	13	13	51	42
Shantz, Ruby	4	13	15	12	44	39

Class V11 A

	Score Test 1	Score Test 11	Score Test 111	Score Test 1V	Total Score	School Average
Shaw, Gerald	27	36	21	20	104	76
Staples, Laverne	7	13	14	23	57	56
Strang, Jane	5	9	9	16	39	43
Theriault, Pat	13	16	6	16	51	62
Thompson, Dennis	14	17	13	17	61	67
Trea, Helen	15	11	15	9	50	62
Waterman, Barbara	11	15	11	10	47	62
Williams, Joan	10	15	13	12	50	46
Wilson, John	12	23	20	22	77	71
	455	735	556	661	2407	2314

Class VII B

	Score Test 1	Score Test 11	Score Test 111	Score Test 1V	Total Score	School Average
Bancroft, Allan	9	19	16	23	67	59
Bjorudson, Vernon	12	26	14	21	73	63
Campbell, Ellen	14	19	16	15	64	56
Campbell, Tom	11	20	18	13	62	60
Clarke, Doris	9	14	14	18	55	59
Clarke, Margaret	9	16	11	10	46	56
Clark, Nora	7	14	10	13	44	45
Cooper, Brenda	7	13	13	19	52	46
Curtis, Muriel	14	17	17	23	71	70
Dobson, Beryl	7	14	9	16	46	54
Duxbury, Jimmy	3	26	14	14	57	41
Frank, Elsa	12	16	15	25	68	51
Hanson, Ronald	11	19	7	16	63	54
Healy, Audrey	13	20	14	19	66	50
Hunter, Jean	8	14	19	20	51	70
Ingelson, Edgar	8	13	11	17	49	64
Johnson, Ronald	7	20	12	16	55	58
Kerslake, BettyLou	6	14	10	10	40	58
Knights, Patricia	8	16	11	16	51	53
Lister, Verna	10	18	16	17	61	57
McNab, Dan	8	16	12	18	54	55
Marcellus, Mary	6	12	11	10	39	40
Meikle, Bob	7	20	14	19	60	43
Mitchell, Irene	5	11	9	14	39	45
Nightingale, Patricia	6	14	10	12	42	54
Pettapiece, Graham	8	20	23	21	72	65
Preece, Gladys	4	16	9	6	35	33
Reid, Ronald	8	16	9	12	45	47
Rhodes, Cecil	24	21	10	26	81	65
Ross, Geraldine	5	11	12	14	52	57

Class Vll B

	Score Test 1	Score Test 11	Score Test 111	Score Test 1V	Total Score	School Average
Russel, Isabel	4	10	9	7	30	32
Sanford, Audrey	12	17	15	22	66	64
Short, Donald	1	10	8	8	27	20
Sheppard, Norma	9	14	11	11	45	47
Tait, Rod	14	16	15	25	70	71
Van Kleet, Eldean	9	6	6	15	36	56
Wallace, Bob	14	18	12	18	62	61
Waller, June	7	15	15	20	57	48
Weale, Ted	16	17	26	13	72	73
Webster, George	10	16	17	26	69	73
	362	644	530	658	2194	2183

CLASS VII C

	Score Test 1	Score Test 11	Score Test 111	Score Test 1V	Total Score	School Average
Armstrong, Jim	6	11	9	14	40	37
Back, Eddy	6	14	9	7	36	40
Boyd, Anna	4	13	12	14	43	50
Brown, Elaine	13	17	8	16	54	65
Bull, Connie	6	12	9	10	37	49
Bunn, Pat	3	18	7	13	41	49
Campbell, Josephine	4	11	12	6	33	36
Chalmers, Jean	7	9	11	13	40	54
Charlton, Max	11	15	16	14	56	59
Cheney, Isabelle	9	8	8	10	35	60
Croucher, Margaret	9	6	10	16	41	56
Dawson, Brock	14	21	11	4	40	48
Dewart, Shelagh	6	14	11	16	46	48
Ferguson, William	11	14	7	12	44	40
Fox, Donald	14	15	13	14	56	60
Freeborn, Bruce	16	19	16	17	68	66
Gates, Sheila	14	16	9	11	50	49
Gray, Pat	8	20	12	11	51	58
Green, Dick	7	25	11	11	54	57
Hamilton, Nicholas	8	8	7	8	31	57
Harrison, Norma	6	14	14	15	49	53
Hunter, Doreen	12	8	10	15	45	62
Johnson, Pearl	13	17	14	11	55	73
Jones, Dick	15	15	8	13	51	57
King, Violet	12	18	16	14	60	65
Kinneard, George	11	21	22	16	70	69
Kirby, John	7	14	11	21	53	52

Class VII C (cont'd)

	Score Test 1	Score Test 11	Score Test 111	Score Test IV	Total Score	School Average
Moseley, Yvonne	10	15	9	12	46	74
Patton, Ken	15	22	19	13	69	73
Sawyers, Ted	13	15	12	20	60	56
Simieson, Chas	8	12	9	9	38	58
Smith, Jack	6	18	15	12	51	55
Smith, Mervin	12	23	17	16	68	56
Steadman, Dorothy	6	25	16	19	66	46
Wade, Edwin	13	11	10	12	46	64
Walker, Douglas	9	12	5	7	32	51
Winchester, Neil	8	10	13	4	32	53
Woods, Barbara	5	14	12	14	45	56
	347	580	430	480	1837	2111

CHAPTER IV

SUMMARIES AND INTERPRETATION OF RESULTS

Three questions came to mind as the marks were tabulated and summarized:

A. How much growth is made in science knowledge, understanding, and concept by pupils in the Junior High School from grade to grade?

B. Do boys have a better grasp of science than girls and progress more rapidly in their mastery of its fundamentals?

C. How does science attainment in each and all of the fields tested compare with the science achievement in regular school work?

The following data including; tabulations, graphs and correlations should throw some light upon these three questions.

A

How much growth is made in science vocabulary, knowledge, understanding and concept by pupils of the Junior High School from grade to grade?

It was felt that perhaps the best way to show this growth from grade to grade was by the use of grade means on the various Tests. These along with their graphical representation follow in the next pages.

TABLE II

Growth in Science Vocabulary

Grade 7 Test I

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
0-1.99	1	1	-5	-5	25
2-3.99	3	2	-4	-8	32
4-5.99	5	15	-3	-45	135
6-7.99	7	25	-2	-50	100
8-9.99	9	20	-1	-20	20
10-11.99	11	16	0	-128	
12-13.99	13	17	1	17	17
14-15.99	15	15	2	30	60
16-17.99	17	4	3	12	36
18-19.99	19	0	4		
20-21.99	21	1	5	5	25
22-23.99	23	0	6		
24-25.99	25	1	7	7	49
26-27.99	27	2	8	16	128
		119		87	625

Range = 27-1 = 26

Standard Deviation = 4.36

Mean = 11 - $\frac{41x2}{119} = 10.31$

P.E. of the Mean = $\pm .269$

Grade 8 Test I

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
2-3.99	3	1	-8	-8	64
4-5.99	5	2	-7	-14	98
6-7.99	7	2	-6	-12	72
8-9.99	9	4	-5	-20	100
10-11.99	11	12	-4	-48	192
12-13.99	13	8	-3	-24	72
14-15.99	15	11	-2	-22	44
16-17.99	17	10	-1	-10	10
18-19.99	19	4	0	-158	
20-21.99	21	10	1	10	10
22-23.99	23	9	2	18	36
24-25.99	25	6	3	18	54
26-27.99	27	4	4	16	64
28-29.99	29	4	5	20	100
30-31.99	31	5	6	30	180
32-33.99	33	1	7	7	49
34-35.99	35	3	8	24	192
36-37.99	37	3	9	27	243
38-39.99	39	3	10	30	300
		101		200	1884

Range = 39-3 = 36

Standard Deviation = 8.70

Mean = 19 - $\frac{42x2}{101} = 19.83$

P.E. of the Mean = $\pm .583$

Grade 9 Test I

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
8-9.99	9	1	-9	-9	81
10-11.99	11	2	-8	-16	128
12-13.99	13	3	-7	-21	147
14-15.99	15	3	-6	-18	108
16-17.99	17	6	-5	-30	150
18-19.99	19	4	-4	-16	64
20-21.99	21	9	-3	-27	81
22-23.99	23	11	-2	-22	44
24-25.99	25	14	-1	-14	14
26-27.99	27	10	0	-173	
28-29.99	29	12	1	12	12
30-31.99	31	12	2	24	48
32-33.99	33	9	3	27	81
34-35.99	35	11	4	44	176
36-37.99	37	4	5	20	100
38-39.99	39	1	6	6	36
40-41.99	41	6	7	42	294
42-43.99	43	3	8	24	192
44-45.99	45	N = 121		199	1756

$$\text{Range } 43-9 = 34 \quad \text{Standard Deviation} = 7.25$$

$$\text{Mean } 27 \neq \frac{26x_2}{121} = 27.43 \quad \text{P.E. of the Mean} = \pm .444$$

From these Tables it is easily seen that there is a real, rapid and almost continuous growth in the use and understanding of scientific words through the Junior High School grades. This is readily seen by the graph below. The figures also indicate that there is a great variation among students of the same grade. e.g. In grade 8 the variation is from 3 to 39 which means that some pupils, even after three terms studying science, have not yet even begun to acquire a science vocabulary necessary at the Junior High School level.

Graph Showing Growth in Science Vocabulary

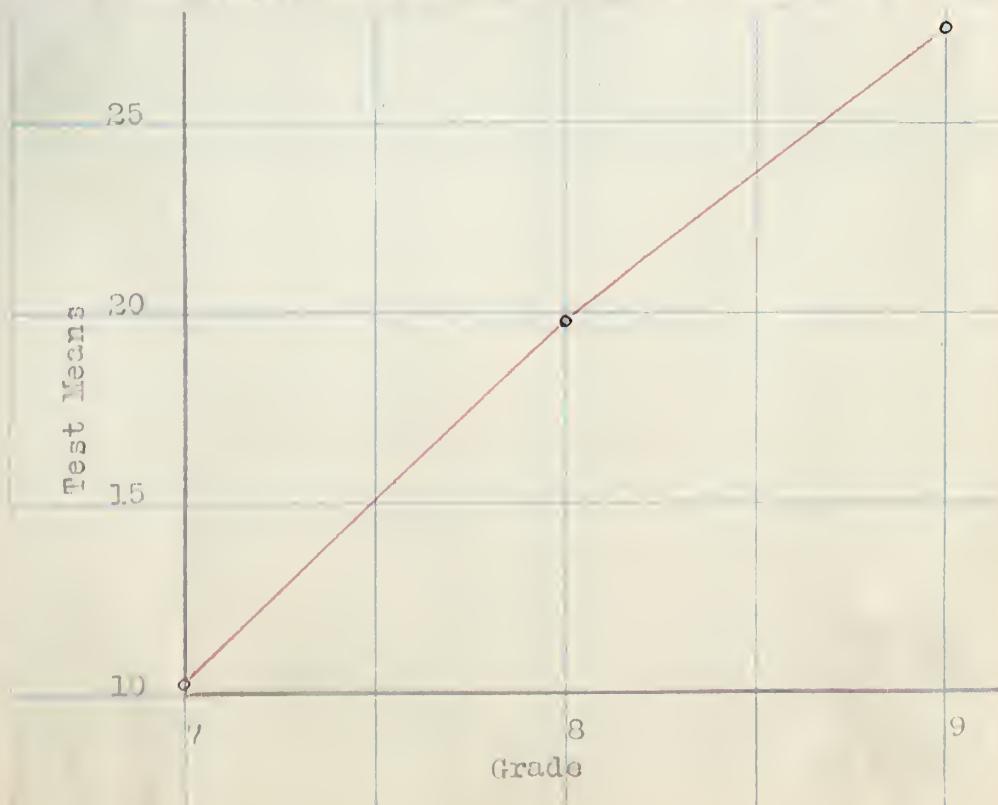


TABLE III
GROWTH IN FACTUAL KNOWLEDGE IN SCIENCE

Grade 7 Test II

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
6-7.99	7	3	-5	-15	75
8-9.99	9	5	-4	-20	80
10-11.99	11	12	-3	-36	108
12-13.99	13	12	-2	-24	48
14-15.99	15	25	-1	-25	25
16-17.99	17	20	0	-120	
18-19.99	19	12	1	12	12
20-21.99	21	12	2	24	48
22-23.99	23	7	3	21	63
24-25.99	25	4	4	16	64
26-27.99	27	3	5	15	75
28-29.99	29	2	6	12	72
30-31.99	31	1	7	7	49
32-33.99	33		8		
34-35.99	35		9		
36-37.99	37		10	10	100
		119		117	819

Range = 36-6 = 30

Standard Deviation = 5.24

Mean = $\frac{17-3x2}{119} = 16.95$

P.E. of the Mean = $\pm .324$

Grade 8 Test II

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
4-5.99	5	1	-9	-9	81
6-7.99	7	1	-8	-8	64
8-9.99	9	3	-7	-21	147
10-11.99	11	2	-6	-12	72
12-13.99	13	3	-5	-15	75
14-15.99	15	6	-4	-24	96
16-17.99	17	13	-3	-39	117
18-19.99	19	8	-2	-16	32
20-21.99	21	10	-1	-10	10
22-23.99	23	10	0	-154	
24-25.99	25	8	1	8	8
26-27.99	27	8	2	16	32
28-29.99	29	6	3	18	54
30-31.99	31	12	4	48	192
32-33.99	33	5	5	25	125
34-35.99	35	2	6	12	72
36-37.99	37		7		
38-39.99	39	2	8	16	128
40-41.99	41		9		
42-43.99	43	1	10	10	100
		101		153	1405

Range = 43-4 = 39

Standard Deviation = 7.46

Mean = $\frac{23-1x2}{101} = 22.98$

P.E. of the Mean = $\pm .500$

Grade 9 Test II

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
8-9.99	9				
10-11.99	11	3	-9	-27	243
12-13.99	13	3	-8	-24	192
14-15.99	15	3	-7	-21	147
16-17.99	17	3	-6	-18	108
18-19.99	19	7	-5	-35	175
20-21.99	21	9	-4	-36	144
22-23.99	23	7	-3	-21	63
24-25.99	25	16	-2	-32	64
26-27.99	27	8	-1	-8	8
28-29.99	29	7	0	-222	
30-31.99	31	11	1	11	11
32-33.99	33	14	2	28	56
34-35.99	35	11	3	33	99
36-37.99	37	7	4	28	112
38-39.99	39	4	5	20	100
40-41.99	41	5	6	30	180
42-43.99	43	2	7	14	98
44-45.99	45	1	8	8	64
		121		172	1864

Range = 44-10 = 34

Standard Deviation = 7.66

Mean = $\frac{29-50 \times 2}{121} = 28.17$

P.E. of the Mean = $\pm .469$

These means would indicate that there is a real growth in factual knowledge in science through the Junior High School grades but that the growth is not quite as rapid from grade 8 to 9 as from grade 7 to 8. The graph below shows this quite clearly. As in vocabulary there seems to be a wide variation in the amount of factual knowledge possessed by various pupils even in the same grade.

Graph Showing Growth in Factual Knowledge in Science

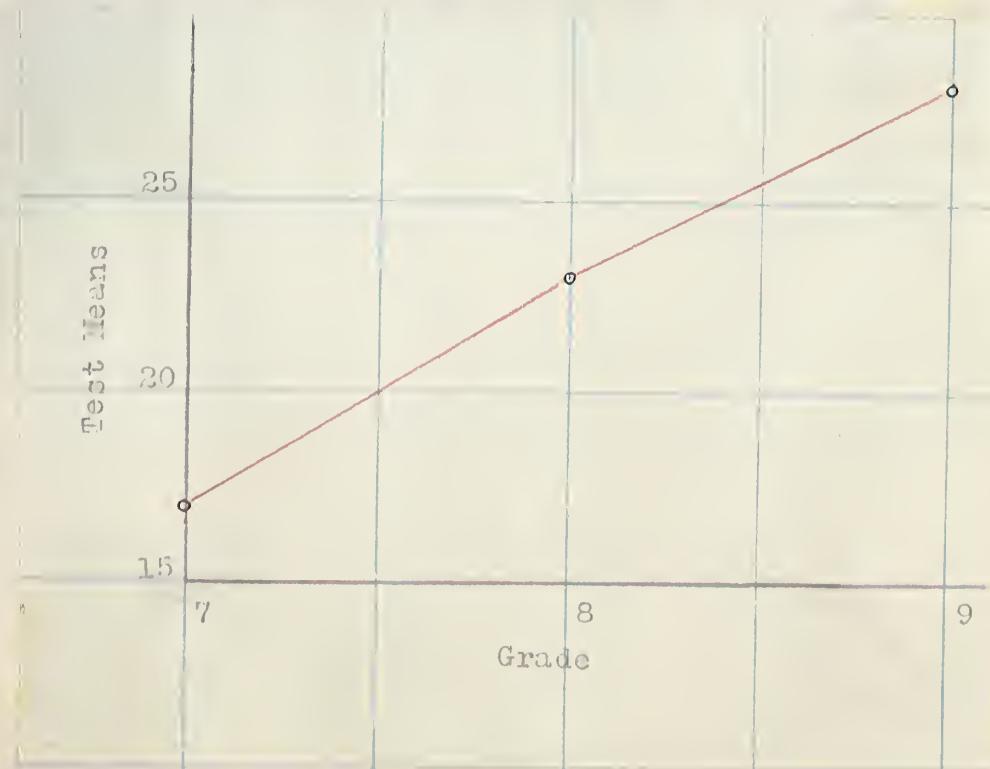


TABLE IV
GROWTH IN APPLICATION OF SCIENTIFIC PRINCIPLES

Grade 7 Test III

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
4-5.99	5	1	-4	-4	16
6-7.99	7	5	-3	-15	45
8-9.99	9	19	-2	-38	76
10-11.99	11	22	-1	-22	22
12-13.99	13	24	0	-79	
14-15.99	15	22	1	22	22
16-17.99	17	14	2	28	56
18-19.99	19	5	3	15	45
20-21.99	21	4	4	16	64
22-23.99	23	2	5	10	50
24-25.99	25		6		
26-27.99	27		7	7	49
28-29.99	29	1		98	445
30-31.99	31				

Range = 26-5 = 21

Standard Deviation = 3.82

Mean = 13 $\neq \frac{19 \times 2}{119} = 13.32$ P.E. of the Mean = $\pm .236$

Grade 8 Test III

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
4-5.99	5	1	-6	-6	36
6-7.99	7	1	-5	-10	50
8-9.99	9	2	-4	-12	48
10-11.99	11	3	-3	-21	63
12-13.99	13	7	-2	-24	48
14-15.99	15	12	-1	-19	19
16-17.99	17	19	0	-92	
18-19.99	19	17	1	16	16
20-21.99	21	16	2	24	48
22-23.99	23	12	3	15	45
24-25.99	25	5	4	16	64
26-27.99	27	4	5	10	50
28-29.99	29	2	6		
30-31.99	31		7		
32-33.99	33		8		
34-35.99	35	1		8	64
36-37.99	37			89	551
38-39.99	39				

Range = 34-6 = 28

Standard Deviation = 4.66

Mean = 19- $\frac{3 \times 2}{101} = 18.94$

P.E. of the Mean = $\pm .312$

Grade 9 Test III

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
8-9.99	9				
10-11.99	11	3	-7	-21	147
12-13.99	13	3	-6	-18	108
14-15.99	15	7	-5	-35	175
16-17.99	17	1	-4	-4	16
18-19.99	19	6	-3	-18	54
20-21.99	21	17	-2	-34	68
22-23.99	23	19	-1	-19	19
24-25.99	25	6	0		
26-27.99	27	15	1	15	15
28-29.99	29	10	2	20	40
30-31.99	31	11	3	33	99
32-33.99	33	9	4	36	144
34-35.99	35	7	5	35	175
36-37.99	37	5	6	30	180
38-39.99	39		7		
40-41.99	41	2	8	16	128
42-43.99	43				
		121		185	1368

$$\text{Range} = 41 - 11 = 30$$

$$\text{Standard Deviation} = 6.62$$

$$\text{Mean} = 25 + \frac{36 \times 2}{121} = 25.59 \quad \text{P.E. of the Mean} = \pm .405$$

By comparing the means on this Test of scientific principles and their application we see that the growth in this field of science through the Junior High School is quite continuous from grade to grade. In fact it appears to speed up slightly from grade 8 to grade 9 instead of slowing down as in the case of Test I and II. The graph below gives some idea of this difference, especially if compared with the two former graphs in this section.

Graph Showing Growth in Knowledge and Application of Scientific Principles

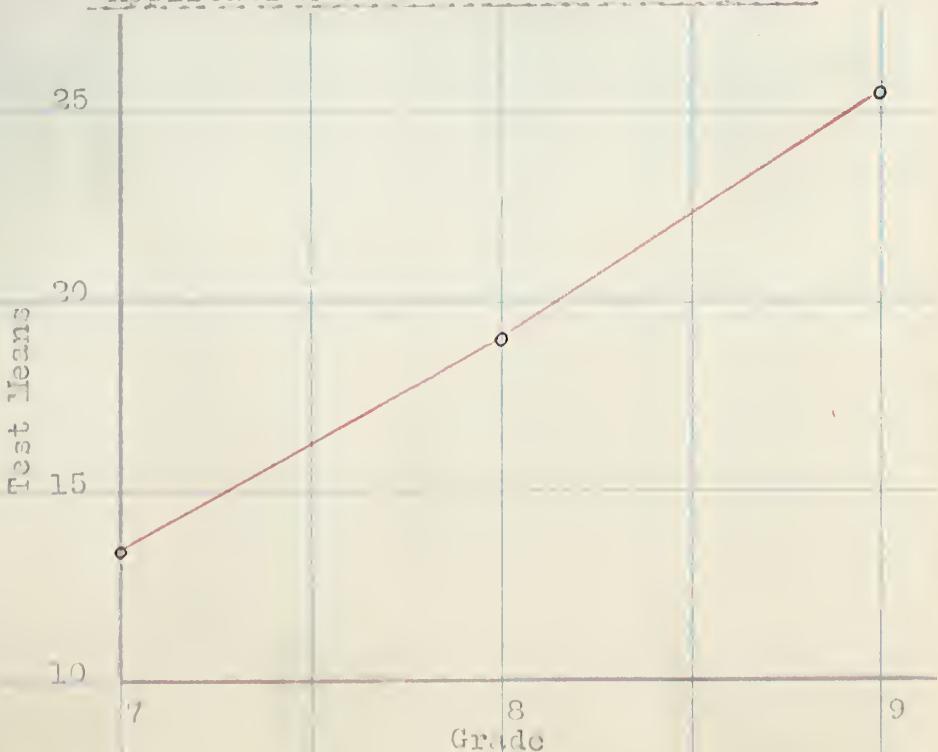


TABLE V
GROWTH IN SCIENTIFIC THINKING
Grade 7 Test IV

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
2-3.99	3				
4-5.99	5	3	-5	-15	75
6-7.99	7	7	-4	-28	112
8-9.99	9	7	-3	-21	63
10-11.99	11	14	-2	-28	56
12-13.99	13	19	-1	-19	19
14-15.99	15	18	0	-111	
16-17.99	17	15	1	15	15
18-19.99	19	17	2	34	68
20-21.99	21	8	3	24	72
22-23.99	23	5	4	20	80
24-25.99	25	4	5	20	100
26-27.99	27	1	6	6	36
28-29.99	29	1	7	7	49
30-31.99	31	<u>119</u>		<u>126</u>	<u>745</u>

$$\text{Range} = 29 - 4 = 25$$

$$\text{Standard Deviation} = 4.98$$

$$\text{Mean} = 15 + \frac{15 \times 2}{119} = 15.25 \quad \text{P.E. of the Mean} = \pm .308$$

Grade 8 Test IV

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
6-7.99	7				
8-9.99	9	5	-6	-30	180
10-11.99	11	4	-5	-20	100
12-13.99	13	9	-4	-36	144
14-15.99	15	13	-3	-39	117
16-17.99	17	8	-2	-16	32
18-19.99	19	9	-1	-9	9
20-21.99	21	11	0	-150	
22-23.99	23	11	1	11	11
24-25.99	25	13	2	26	52
26-27.99	27	9	3	27	81
28-29.99	29	3	4	12	48
30-31.99	31	4	5	20	100
32-33.99	33	1	6	6	36
34-35.99	35	1	7	7	49
36-37.99	37	<u>101</u>		<u>109</u>	<u>959</u>

$$\text{Range} = 34 - 7 = 27$$

$$\text{Standard Deviation} = 5.94$$

$$\text{Mean} = 21 - \frac{41 \times 2}{101} = 20.19 \quad \text{Probable Error of mean} = \pm .398$$

Grade 9 Test IV

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd^2
6-7.99	7	1	-8	-8	64
8-9.99	9		-7		
10-11.99	11	4	-6	-24	144
12-13.99	13	2	-5	-10	50
14-15.99	15	8	-4	-32	128
16-17.99	17	4	-3	-12	36
18-19.99	19	8	-2	-16	32
20-21.99	21	11	-1	-11	11
22-23.99	23	22	0	-113	
24-25.99	25	18	1	18	18
26-27.99	27	20	2	40	80
28-29.99	29	15	3	45	135
30-31.99	31	4	4	16	64
32-33.99	33	3	5	15	75
34-35.99	35	1	6	6	36
36-37.99	37	<u>121</u>		<u>140</u>	<u>873</u>

$$\text{Range} = 37 - 7 = 30$$

$$\text{Standard Deviation} = 5.29$$

$$\text{Mean} = 23 \neq \frac{27 \times 2}{121} = 23.45 \quad \text{P.E. of the Mean} = \pm .324$$

From these figures it would appear that there is quite a development in reflective thinking among pupils of Grade 7 to Grade 9 although it is not nearly as pronounced as in the other three fields tested. However, a closer scrutiny of the test scores will throw some light upon this point. In marking the test papers it was found that this was the only Test which was not completed by the average pupil of all three grades. It was noticed that the Grade 9 pupils seemed to have the advantage of being swifter readers and faster workers, so that the total average score on this Test can not be taken as a criterion for comparing pupil ability in all grades in reflective thinking. It was found that although the average pupil of Grade 9 finished to question 7, the average pupil of Grade 8 only finished to question 6, while the average in Grade 7 only finished to question 5. For this reason it was thought best to mark and tabulate Test IV question by question and compare these means to obtain a fairer estimate of pupil ability on this Test. These tabulations and comparisons therefore follow immediately. Wherever a blank was left in the tabulation that question was not attempted; a "W" meant that the question was attempted but was wrongly interpreted; while a "0" meant that the question was understood and attempted but the answer was worth nothing.

TABLE VI
 SUMMARIES OF TEST IV

Class IX A.

		Marks per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Agate,	Ruth	9	2	6	4	2	3		26
Anderson,	Dorothy	9	2	3	4	2			20
Areano,	Walter	11	1	5	0	2	4		23
Armstrong,	Nelson	9	4	6	4	3			26
Boyd,	Sarah	6	2	5	2	0			15
Brewis,	Rachel	9	3	3	1	6			22
Carter,	Mervyn	7	2	3	1	2			15
Cambell,	Colin	11	2	3	2	7	3		28
Cove,	Jack	10	2	6	2		3		23
Dowsett,	Hilda	3	3	3	2	2	3		16
Dowling,	Mildred	8	3	6	4	6	3		30
Fox,	Margaret	6	0	2	3	1	1		13
Fair,	Jack	8	3	6	4	3			24
Gee,	Norma	9	1	6	3	5			24
Gibson,	Olive	9	2	3	1	3	3	3	24
Hall,	Marguerite	11	2	3	3	3	4	1	27
Hatfield,	Bruce	10	3	6	3				22
Hewitt,	Catherine	6	1	2	4	8	3		24
Ingham,	Hazel	12	0	6	3				21
Johnson,	Ken	9	2	6	3	5			25
Jenkins,	Bill	10	3	4	3	5	1		26
La Rue,	Eugene	6	2	5	4	6	4		27
Matthews,	John	10	3	6	3	5	4	2	33
Miller,	Jim	11	1	3	3	6	3		27
Morrison,	Gerry	9	4	6	4	5	1		29
Mitchell,	Irma	3	4	0	1	3			11
Meldon,	Carol	9	1	6	3	3	3		25
McNab,	Gladys	11	1	5	3	2	3	3	28
Nielson,	Dorothy	10	1	6	2	4	3		26
Pearson,	Betty	11	3	6	2	2			24
Patton,	Bud	8	3	3	4	5	3		26
Rowe,	Bernard	7	3	4	3	3	1		21
Steadman,	Stanley	4	2	3	3	7	2	1	22

		Marks per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Strang,	John	9	2	6	4	4			25
Strange,	Marjorie	5	1	3	2				11
Starrat,	Gordon	4	1	6	2	5	1	2	21
Talbot,	Betty	6	0	4	1	3			14
Timmons,	Dorothy	8	3	5	1	2	3		22
Tisdell,	Jean	6	3	6	4	3	3	3	28
Tureranneaid,	Edwin	7	1	3	2	5			18
Wells,	Gordon	11	1	3	2	4	3	3	27
Willis,	Melvin	8	2	6	2	4	2		24
		345	85	188	111	146	70	18	963

		Marks per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Ashley,	Irene	8	2	4	3	2	1		20
Bancroft,	Donald	10	3	6	1	5	3	3	31
Beatty,	Alex	6	2	3	1	5	2	3	22
Birchall,	Margaret	8	3	6	4	6	3	0	30
Brailey,	Ella	8	3	6	3	4			24
Brand,	Laura	6	2	4	1	5	3		21
Brandon,	Marjorie	6	2	4	3	3	1		19
Browning,	Charles	11	2	5	2	4	0		24
Campbell,	Irene	2	0	3	1	0	1		7
Clifford,	Marian	6	3	3	3	5	2		22
Cooper,	George	5	2	5	2	3	3		20
Davis,	William	9	2	6	3	6	3		29
Dowling,	Lorne	8	3	6	4	6	2		29
Faunt,	Robert	8	1	6	3	6			24
Fitzsimmons,	Wesley	8	2	6	3	7	2		28
Gardner,	Laurine	7	2	3	3	2	0	1	18
Garner,	Mona	5	2	6	3	6			22
Hunter,	Margaret	5	0	6	2	4	2	0	19
Johnstone,	George	8	1	2	1	2			14
Jones,	Marjorie	9	3	6	4	7	2	2	33
Kraft,	Frances	9	2	4	4	4	2		25
Lamb,	Marguerite	9	1	6	2	1	2	2	23
Mann,	Donald	8	3	6	4	5	3		29
Martin,	Elmer	4	1		2	4			11
McPhee,	Jean	7	2	3	2	3			17
Monroe,	Genevieve	7	2	5	0	5	1	2	22
Newinger,	Donald	9	1	5	2	4	3	2	26
Parnell,	Fred	9	1	6	1	6			23
Roberts,	Charles	10	3	6	3	6	3		31
Souther,	Francis	10	1	6	0	6	3	2	28
Steele,	Margery	10	1	3	3	4	2	2	25
Stephens,	Edith	7	3	5	2	4	3	2	26
Strange,	Dorothy	7	3	5	1	6	0		21

Class IX.B - continued

		Hours Per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Underhill, Catherine		7	2	6	2	4	3	2	26
Wallace, Alexander		10	1	0	1	2			14
West, Derek		9	2	6	2	7	2		28
Williams, Eileen		10	4	3	2	3			22
Young, Mildred		10	4	6	4	4	2	2	32
		295	76	177	87	166	59	25	885

Class IX C

		Marks per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Campbell,	Dorothy	6	1	2	3	4	2	1	19
Carosey,	Audrey	11	1	3	2	6	3	2	28
Cozzubbo,	Margaret	6	2	2		2	1		13
Craig,	Kenneth	7	3	4	2	4	3		23
Daniel,	Robert	7	1	2	2	3			15
Delay,	Frank	5	2	4	1	3	2	2	19
Geddes,	Kenneth	7	2	6	2	5	4	2	28
Godlonton,	Pearl	11	0	4	3	3	2	3	26
Guthrie,	Ruby	10	2	6	3	2	3	1	27
Hallberg,	Margaret	8	3	6	2	4	3		26
Hambrook,	Mary	7	0	6	2	3	3	1	22
Harvey,	Elsie	8	0	5	3	2			18
Hendry,	Evelyn	11	4	6	4	5	2	2	34
Hess,	Louise	8	3	3	1	2	2	3	22
Hopkins,	Marion	10	2	6	2	1	2	1	24
Jordan,	Marie	9	2	5	3	4	3	2	28
Kerslake,	Thelma	9	2	6	2	2	2	2	25
Lawson,	Barbara	8	1	2	4	3	2	3	23
Lee,	Peggy	10	2	5	2	3	2	2	26
Leighton,	Rita	7	4	4	4	2	3	3	27
Lumby,	Doris	6	1	4	2	2	2	1	28
Martin,	Jim	7	3	5	3	6	2	1	27
Marston,	Allan	10	1	6	3	5	2		27
McMurray,	Dave	6	1	3	0	3	2		15
Meikle,	Donald	7	1	2	4	3			17
Neilson,	Cecil	9	3	3	2	5	1	2	25
O'Neill,	Margaret	8	2	4	3	2	1		20
Riley,	Leonard	10	2	4	2	7	1	3	29
Robertson,	Noreen	7	0	4	2	2			15
Rose,	Jack	4	3	5	2	5	3		21
Schroeder,	Dorothea	9	3	0	0	3	3	2	20
Shantz,	Patsy	8	1	5	3	4	2		23
Stucky,	William	10	0	6	3	5	2		26
Talerio,	Pat	7	2	0	2	0	0		11

Class IX C - Continued

		Marks per Question							<u>Total</u>
1.	2.	3.	4.	5.	6.	7.			
Upton, Gordon		8	2	6	3	4	2		25
Urquhart, Robert		12	2	3	0	6			23
West, Yvonne		6	3	3	4	2	2	3	23
Ware, Roy		6	2	5	2	4	2	2	23
Williams, Erskine		10	1	5	3	6	2	2	29
Winchester, Alice		5	2	5	4	2	2	3	23
Woodrow, Lloyd,		7	1	2	2	2	2		16
		327	73	167	96	141	77	49	930

Class VIII A

		Marks per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Anderson, Olive		11	3	6	3	6	2	3	34
Annlegate, Barry		10	2	6	2	5	2		27
Bull, Douglas		6	2	0	0				8
Campbell, Evelyn		9	3	2	2	1		1	18
Chisolm, James		12	2	0	2	4	3	3	26
Christie, Shirley		6	2	5	3			2	18
Church, Audrey		6	0	2	2	3			13
Clarke, Robert		9	1	5	2	3	3	3	26
Cook, Jean		6	2	5	2				15
Doten, Verne		10	2	2	3	5			22
Forzaine, Bart		9	0	0	0	0			9
Gardner, Donald		5	1	2	1				9
Gilbert, Joyce		8	2	5	3	1	1	2	22
Goodwin, James		9	2	3	2	8			24
Haworth, John		5	2	4	1	3			15
Johnson, Wallace		5	1	3	2	2			13
King, Marie		7	W	2	1				10
Knight, Marie		7	2	2	1	1			13
Long, Roberta		7	1	1	0				9
Mathew, Peter		7	2	5	1	6	3		24
Morrice, Jean		6	1	5	4	2			18
Myra, Berna		8	2	5	2				17
Parder, Ruth, Evelyn		9	2	2	2	3	2		20
Pierce, Hazel		7	3	6	3	3	3		25
Rees, Cynthia		8	2	6	2	3	2		23
Robb, Gordon		8	3	5	4	7	0		27
Shantz, Helen		5	3	1	2				11
Sommerville, Thomas		9	0	0	1			2	12
Staley, Howard		7	4	2	0	3	2		18
Taylor, Duncan		11	1	6	3	6	3		30
Thompson, Donna		7	1	2	1	3			14
Allrich, Joyce		8	2	3	3	3	3	3	25
Ward, Mary		11	2	5	3	3			24
Wilmott, Lois		10	3		3	6	0	2	24
Young, Lorraine		11	2	5	2	6	2	2	30

Class VIII B

58

		Marks per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Aikenhead, Donald		10	1	4	3	6	4	2	30
Baker, Frances		7	3	0	4				14
Baker, Horace		3	3	3	2	4	1		16
Broughton, Irene		7	1	4	0	W	2		14
Collison, Lawrence		9	2	2	3	3	3	2	24
Devis, Rosetta		6	4	2	2	3			17
Dingle, Donald		10	1	6	2	2			21
Edwards, Margaret		9	1	6	3	6	3		28
Ellison, John		6	0	3	4	5	3		21
Gilbert, Joyce		8	2	5	3	1	1	2	22
Goddard, Norma		10	1	3	3	3	3	1	24
Goudy, Norma		7	2	5	3	1	3	2	23
Hamilton, Alice		6	1	6	3	1			17
Hooks, Shirley		11	2	4	2	3	4	3	29
Kraft, Norman		6	3	0	0	1			10
Larkin, Tom		3	0	3	0	4			10
Lindseth, Joyce		8	3	6	4	6	3	2	32
Lyons, Muriel		6	3	1	3	3	2		18
McCullagh, Jack		6	0	2	1	3	W	2	14
McLellan, Marguerite		10	2	5	3	2			22
McReynolds, Ann		9	3	2	4	4	1		23
McTeer, Joan		10	3	0	3	4		1	21
Matthews, Violet		5	0	2	2	2		3	14
Montalbett, Earl		8	2	5	4	4	1		24
Newborn, Ronald		3	2	2	1	1	4	2	15
Nicholson, Willard		9	2	3	2	3			19
Pecover, Jack		8	1	2	4	5	3	2	25
Peebles, Corrine		8	1	2	3	1	1	2	18
Postlewaite, Marg.		7	2	4	3	3	3		22
Proctor, William		8	1	0	2	4			15
Roe, Richard		7	0	3	3	3	2	2	20
Ryder, Jessie		8	2	5	3	2	2	3	25
Sagan, Joe		9	W						9
Starratt, Margaret		6	1	6	0	0	2	3	18
Tregillus, Marion		9	2	2	0	2	1		16

Class VIIIC

		Marks per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Abernethy, Bill		8	1	5	2	4	0	0	20
Appleby, Mary		8	W	5	3	W			16
Armstrong, Mirriam		11	1	5	3	4	3		27
Atkinson, Jim		8	2	3	3	5			21
Barnes, Aileen		8	1	0	1	1	2	2	15
Cozzubo, Hazel		6	2	2	0	1	0	2	13
Davis, Joan		11	W	4	W	2	2	2	21
D'Eath, Bob		10	1	6	3	3	2	2	27
DeKelver, Bernice		7	2	4	1	2			16
Draper, Barbara		8	1	6	3	4	4		26
Ferrie, Betty		6	1	3	0	3	3		16
Fraser, Jim		6	1	3	3	6	3	2	24
Gee, Dick		8	3	3	1	3	4	3	25
Hamilton, Wilson		10	3	3	3	5	3		27
Holman, Linda		8	2	3	2	4	3		22
Kinder, Margaret		6	1	3	0	0	2		12
Jones, Eunice		10	0	0	1	3			14
Lambly, Norman		10	3	5	1	4	4	3	36
Leighton, Charlie		5	0	0	1	4	3	2	15
Long, Stella		8	1	4	1	4	2	3	23
Lott, Norma		6	0	4	2	1	2		15
Lyons, Dorothy		3	1	5	0	1	3	0	13
Mannen, Delight		5	0	5	3				13
Murray, Hubert		8	2	4	1	4	3	1	23
McCullough, Joyce		12	1	1	3	4			21
Nichols, Beverly		9	0	3	3	4	2	1	22
Stark, Barbara		7	2	0	2	3	2	1	17
Stickney, Jim		9	1	1	3	2	2		18
Stockdale, Don		9	1	6	3	5	2		26
Symons, Doreen		6	1	2	3	2	4	3	21
Tewksbury, Aurora		7	2	6	3	5	3	2	28
Wallace, Shirley		4	1	3	2		2		12
Wilson, John		8	3	1	2	4	3		21

		Marks per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Alger,	Grant	8	2	4	4	2			20
Beezley,	Shirley	8	2	6	3				19
Beeby,	Vivian	7	1	6	1	3	2		20
Bell,	Gordon	10	3	5	4	7			29
Benson,	Gladys	2	3	4	3	6	4		22
Burrows,	Bill	8	2	1	3	4	3		21
Cook,	Paul	8	W	W	W				8
Delaine,	Joyce	3	3	5	3	0		2	16
Desson,	Mary	3	0	0	0	1			4
Frost,	Ken	7	3	2	3	4			19
Girling,	Roy	6	1	3	2	3	3	2	20
Hallberg,	Lawrie	W	3	4	2	6			15
Hatfield,	Bob	7	1	3	4	3	4	3	25
Henderson,	Eileen	8	2	3	1	4			18
Hepple,	Jacqueline	8	0	1	0		2	2	13
Hornby,	George	6	1	5					12
Leinweber,	Murray	W	2	3	2				7
Love,	Walter	8	2	0	2	5	3		20
Matin,	Joyce	6	2	3	2	2	3		18
Martin,	Doug	8	2	0	2		3		15
McIver,	Stan	6	1	5	3	4			19
Moore,	Miriam	7	1						8
Moore,	Don	7	0	4	2	1	3		17
Munroe,	Barbara	4	2		3				9
Nevard,	Eileen	9	2	4	2	1			18
Orchard,	James	4	2	3	2	3			14
Poffenroth,	Henry	9	1		3	3			16
Roberts,	Gordon	9	0	3	3	4			19
Robinson,	Rose	7	1	3	2	3			16
Ritchie ,	Gordon	7	2	3	2				14
Salway,	Millie	3	2	5	2	1			13
Shantz,	Ruby	5	3	4		0			12
Shaw,	Gerald	9	1	2	3	5			20
Staples,	Laverne	11	1	5	4		2		23

CLASS VII A - Continued

		Marks per Question							<u>Total</u>
		1.	2.	3.	4.	5.	6.	7.	
Strang,	Jane	10	0	2	3	1			16
Strong,	Don	3	1	1	0	0	2		7
Theriault,	Pat	5	2	5	3	1			16
Thompson,	Dennis	9	0	2	2	4			17
Treca,	Helen	4	1	2		2			9
Waterman,	Barbara	5	1	2	2				10
Williams,	Joan	6	2	3	1				12
Wilson,	John	10	1	3	3	5			22
		270	62	119	86	88	34	9	668

CLASS VII B.

		Marks per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Bancroft,	Allan	9	1	6	4	3			23
Bjorudson,	Vernon	5	2	6	0	4			17
Campbell,	Ellen	5	1	5	0	4			15
Campbell,	Tom	4	1	3	1	1	3		13
Clarke,	Doris	7	1	5	2	3			18
Clarke,	Margaret	7	2	1	0				10
Clarke,	Nora	5	1	2	3	2			13
Cooper,	Brenda	9	2	3	2	3			19
Curtis,	Muriel	8	2	6	4	3			23
Dobson,	Beryl	7	2	0	2	3		2	16
Duxbury,	Jimmy	5	2	0	2	1	1	1	14
Frank,	Elsa	8	3	6	2	3	3		25
Hanson,	Ronald	4	1	3	3	5			16
Healy,	Audrey	7	3	4	5				19
Hunter,	Jean	10	2	6	0	2			20
Ingelson,	Edgar	7	2	5	1	2			17
Johnson,	Ronald	7	1	5	3				16
Kerslake,	Betty Lou	7	0		3	0			10
Knights,	Patricia	9	3		4				16
Lister,	Verna	4	2	5	1	5			17
McNab,	Dan	8	0	3	4	3			18
Marcellus,	Mary	8	2	W	W	W			10
Meikle,	Bob	9	2	0	3	3	1	1	19
Mitchell,	Irene	7	3	1	1	2			14
Nightingale,	Patricia	7	1	3	1				12
Pettapiece,	Graham	6	2	2	3	6	2		21
Pierce,	Gladys	6	W	W	W				6
Reid,	Ronald	6	2	4	0				12
Rhodes,	Cecil	10	2	3	3	3	3	2	26
Ross,	Geraldine	6	1	3	1	0	1	2	14
Russel,	Isabel	1	1	3	W		2		7
Sanford,	Audrey	6	2	6	2	6			22
Short,	Donald	3	1	1	3				8
Stupnard,	Norma	3	1	4	1	0		2	11

CLASS VII B - Continued

		Marks per Question							<u>Total</u>
		<u>1.</u>	<u>2.</u>	<u>3.</u>	<u>4.</u>	<u>5.</u>	<u>6.</u>	<u>7.</u>	
Tait,	Rod	12	1	6	2	4			25
Van Kleet,	Eldean	6	4	2	1			2	15
Wallace,	Bob	10	1	3	2	2			18
Waller,	June	9	3	3	3	2			20
Weale,	Ted	6	2	2	0			3	13
Webster,	George	9	1	6	4		4	2	26
		272	66	126	76	75	25	12	652

CLASS VII C

		Marks per Question							Total
		1.	2.	3.	4.	5.	6.	7.	
Armstrong,	Jim	9	2	3	0				14
Back,	Eddy	3	1	2	1				7
Boyd,	Anna	10	1	2	1				14
Brown,	Elaine	9	0	4	3	X			16
Bull,	Connie	7	1	2					10
Bunn,	Pat	8	0	1	2	2			13
Campbell,	Josephine	4	1	1					6
Chalmers,	Jean	8	1	3	1				13
Charlton,	Max	9	2	3	0				14
Cheney,	Isabelle	5	2	0	3				10
Croucher,	Margaret	8	3	4	1				16
Dawson,	Brock	W	1	3					4
Dewart,	Shelagh	6	2	2	2	3			15
Ferguson,	William	3	3	5	1				12
Fox,	Donald	5	3	3	0	3			14
Freeborn,	Bruce	12	3	2	0				17
Gates,	Sheila	3	2	2	4				11
Gray,	Pat	8	3						11
Green,	Dick	6	3	2					11
Hamilton,	Nicholas	2	1	3	2	W			8
Harrison,	Norma	5	2	6	2				15
Hunter,	Doreen	6	4	5	0				15
Johnson,	Pearl	7	1	1	2				11
Jones,	Dick	7	1	4	1				13
King,	Violet	8	2	4	0				14
Kinneard,	George	7	3	3	3				16
Kirby,	John	9	3	6	3				21
Moseley,	Yvonne	6	0	6					12
Patton,	Ken	8	3	2					13
Sawyers,	Ted	10	1	6	3				20
Simieson,	Charlie	7	2						9
Smith,	Jack	8	2	0		2			12
Smith,	Mervin	10	3	3					16

CLASS VII C - Continued

		Marks per Question							<u>Total</u>
		1.	2.	3.	4.	5.	6.	7.	
Sleadman,	Dorothy	5	2	6	3	3			19
Wade,	Edwin	6	1	2	3				12
Walker,	Douglas	4	1	2					7
Winchester,	Neil	4	W	W					4
Woods,	Barbara	7	0	3	4				14
		249	67	106	45	11	2		480

TABLE VII

SYNOPSIS OF TEST IV

Question	Grade 7 Average	Grade 8 Average	Grade 9 Average	Total Mark
1	6.7	7.7	8.0	15
2	1.7	1.6	1.9	4
3	3.3	3.3	4.4	6
4	2.0	2.1	2.4	5
5	3.1	3.3	4.1	12
6	2.4	2.3	2.3	4
7	2.0	2.1	2.1	4

From this Table one would conclude that there is really no significant growth in the Science concept in pupils during their stay in the Junior High School. In other words their ability to think reflectively is not much greater at the end of grade nine than at the beginning of grade seven. However, in one or two fields they seem to have made some growth.

Question 1 seems to show a steady and substantial growth. This would mean that perhaps there is some development in the ability to perceive causal relationships in these grades. In question 3 there seems to be a rather unusual rise between grade 8 and 9 which is difficult to account for unless it is due to a chance error. In question 5 there seems to be a somewhat definite growth from grade to grade and I suppose that this is to be expected because this question had to do with the ability of pupils to draw conclusions from data or given facts. On the whole it seems that the growth is too small to call for any comment.

B

Do boys have a better grasp of science than girls and progress more rapidly in their mastery of its fundamentals?

This question was attacked in much the same way as question 1. That is by a comparison of the various means in the following Tables.

TABLE VIII

TABULATION OF DATACOMPARISON OF BOYS' AND GIRLS' SCORES

Grade 7 Girls - Test 1

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd^2
2-3.99	3	1	-3	-3	9
4-5.99	5	12	-2	-24	48
6-7.99	7	15	-1	-15	15
8-9.99	9	11	0	-42	
10-11.99	11	8	1	8	8
12-13.99	13	9	2	18	36
14-15.99	15	5	3	15	45
		<u>61</u>		<u>41</u>	<u>161</u>

Range = 17-3 = 14

Standard Deviation = 3.24

Mean = $9 - \frac{1x2}{61} = 8.94$

P.E. of the Mean = $\pm .279$

Grade 7 Boys - Test 1

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd^2
0-1.99	1	1	-5	-5	25
2-3.99	3	1	-4	-4	16
4-5.99	5	2	-3	-6	18
6-7.99	7	10	-2	-20	40
8-9.99	9	9	-1	-9	9
10-11.99	11	8	0	-44	
12-13.99	13	9	1	9	9
14-15.99	15	10	2	20	40
16-17.99	17	4	3	12	36
18-19.99	19		4		
20-21.99	21	1	5	5	25
22-23.99	23		6		
24-25.99	25	1	7	7	49
26-27.99	27	1	8	8	64
28-29.99	29	1	9	9	81
		<u>58</u>		<u>70</u>	<u>412</u>

Range = 29-1 = 28

Standard Deviation = 5.02

Mean = $11 - \frac{26x2}{58} = 11.88$ P.E. of the Mean = $\pm .445$

Difference between the Means = $11.88 - 8.94 = 2.94$

Probable Error of the Means = $\pm .524$

Critical Ratio = 5.6

These Tables and figures would indicate that there is a significant difference between boys and girls in Science vocabulary and that the boys are superior. If we compare this figure of 2.94 with the figure 9.54 which is the difference between the Grade 7 and Grade 8 level we see that the girls are retarded from three to four months compared with the boys in Science vocabulary.

TABLE IX

Comparison of boys' and girls' scores (continued)

Grade 7 Girls - Test 11

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
6-7.99	7	3	-4	-12	48
8-9.99	9	4	-3	-12	36
10-11.99	11	7	-2	-14	28
12-13.99	13	8	-1	-8	8
14-15.99	15	17	0	-46	
16-17.95	17	13	1	13	13
18-19.99	19	5	2	10	20
20-21.99	21	3	3	9	27
22-23.99	23				
24-25.99	25	1	4	4	16
		61		36	196

Range = 25-6 = 19

Standard Deviation = 3.52

Mean = 15 - $\frac{10x2}{61}$ = 14.68 P.E. of the Mean = $\pm .304$

Grade 7 Boys - Test 11

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
8-9.99	9	1	-5	-5	25
10-11.99	11	5	-4	-20	80
12-13.99	13	5	-3	-15	45
14-15.99	15	7	-2	-14	28
16-17.99	17	7	-1	-7	7
18-19.99	19	7	0	-61	
20-21.99	21	9	1	9	9
22-23.99	23	7	2	14	28
24-25.99	25	3	3	9	27
26-27.99	27	3	4	12	48
28-29.99	29	2	5	10	50
30-31.99	31	1	6	6	36
32-33.99	33		7		
34-35.99	35		8		
36-37.99	37	1	9	9	81
		58		69	464

Range = 37-9 = 28

Standard Deviation = 5.62

Mean = 19 $\neq \frac{8x2}{58}$ = 19.28 P.E. of the Mean = $\pm .498$

Difference between the Means = 19.28-14.68 = 4.60

Probable error of the Means = $\pm .583$

Critical Ratio = 7.89

From these figures it is readily seen that the Grade 7 boys far surpass the girls in factual knowledge in Science.

Comparing the means of Grade 7 and Grade 8 with a difference of 6.03 it would seem that the boys are some eight or nine months ahead of the girls. However it is rather interest-

Comparison of boys' and girls' scores (continued)

ing to note that in this Test as in Test 1 there is a much greater variation in the boys' scores than in girls'.

Comparison of boys' and girls' scores (continued)

Grade 7 Girls- Test 111

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
4-5.99	5	1	- 4	-4	16
6-7.99	7	3	- 3	-9	27
8-9.99	9	13	- 2	-26	52
10-11.99	11	14	- 1	-14	14
12-13.99	13	12	0	-53	
14-15.99	15	11	1	11	11
16-17.99	17	6	2	12	24
18-19.99	19	1	3	3	9
		61		26	153

Range = 19-4 = 15

Standard Deviation = 2.62

Mean = 13 - $\frac{27x2}{61} = 12.12$ P.E. of the Mean = $\pm .225$

Grade 7 Boys - Test 111

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	FD ²
4-5.99	5	1	- 5	-5	25
6-7.99	7	2	- 4	-8	32
8-9.99	9	6	- 3	-18	54
10-11.99	11	8	- 2	-16	32
12-13.99	13	12	- 1	-12	12
14-15.99	15	10	0	-59	
16-17.99	17	8	1	8	8
18-19.99	19	4	2	8	16
20-21.99	21	4	3	12	36
22-23.99	23	2	4	8	32
24-25.99	25		5		
26-27.99	27	1	6	6	36
		58		42	283

Range = 26-5 = 21

Standard Deviation = 4.24

Mean = 15 - $\frac{17x2}{58} = 14.41$ P.E. of the Mean = $\pm .375$

Difference between the means = 14.41-12.11 = 2.30

Probable Error of the Means = $\pm .437$

Critical Ratio = 5.26

It is of interest to note that the Grade 7 girls do not seem to lag so far behind the boys in understanding and use of Scientific principles as in factual knowledge. There is a significant difference between boys and girls but only amounting to about four months instead of eight. It is probably just chance that there is not a greater difference in this Test in Grade 7 because the Grade 8 and 9 classes

Comparison of boys' and girls' scores (continued)

show more difference in favor of the boys.

TABLE XI

Comparison of boys' and girls' scores (continued)

Grade 7 Girls - Test 1V

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
4-5.99	5	1	-5	-5	25
6-7.99	7	3	-4	-12	48
8-9.99	9	3	-3	-9	27
10-11.99	11	11	-2	-22	44
12-13.99	13	8	-1	-8	8
14-15.99	15	9	0	-56	
16-17.99	17	10	1	10	10
18-19.99	19	8	2	16	32
20-21.99	21	4	3	12	36
22-23.99	23	3	4	12	48
24-25.99	25	1	5	5	25
		61		55	303

Range = 25-5 = 20

Standard Deviation = 4.46

Mean = 15 - $\frac{1x2}{61}$ = 14.97 P.E. of the Mean = $\pm .385$

Grade 7 Boys - Test 1V

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
4-5.99	5	2	-6	-12	72
6-7.99	7	2	-5	-10	50
8-9.99	9	5	-4	-20	80
10-11.99	11	1	-3	-3	9
12-13.99	13	9	-2	-18	36
14-15.99	15	8	-1	-8	8
16-17.99	17	10	0	-70	
18-19.99	19	5	1	5	5
20-21.99	21	9	2	18	36
22-23.99	23	2	3	6	18
24-25.99	25	3	4	12	48
26-27.99	27	1	5	5	25
28-29.99	29	1	6	6	36
		58		52	423

Range = 29-4 = 25

Standard Deviation = 5.24

Mean = 17 - $\frac{19x2}{58}$ = 16.35 P.E. of the Mean = $\pm .464$

Difference between the Means = 16.35-14.97 = 1.38

Probable Error of the Means = $\pm .61$

Critical Ratio = 2.26

Since the critical ratio is less than 4 we can assume that on this Generalization Test the girls do approximately as well as the boys. This is the only Test on which their performance is equal to that of the boys, or nearly so.

TABLE XII

Comparison of boys' and girls' scores (continued)

Grade 8 Girls - Test 1

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
2-3.99	3	1	-8	-8	64
4-5.99	5	2	-7	-14	98
6-7.99	7	2	-6	-12	72
8-9.99	9	2	-5	-10	50
10-11.99	11	9	-4	-36	144
12-13.99	13	5	-3	-15	45
14-15.99	15	6	-2	-12	24
16-17.99	17	6	-1	-6	6
18-19.99	19	1	0	-113	
20-21.99	21	4	1	4	4
22-23.99	23	4	2	8	16
24-25.99	25	4	3	12	36
26-27.99	27	2	4	8	32
28-29.99	29	3	5	15	75
30-31.99	31	2	6	12	72
32-33.99	33		7		
34-35.99	35	1	8	8	64
36-37.99	37	2	9	18	162
38-39.99	39	2	10	20	200
		58		105	1164

Range = 38-2 = 36

Standard Deviation = 8.94

Mean = 19 - $\frac{8x2}{58}$ = 18.74 P.E. of the Mean = $\pm .791$

Grade 8 Boys - Test 1

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
8-9.99	9	2	-6	-12	72
10-11.99	11	2	-5	-10	50
12-13.99	13	3	-4	-12	48
14-15.99	15	5	-3	-15	45
16-17.99	17	4	-2	-8	16
18-19.99	19	3	-1	-3	3
20-21.99	21	6	0	-60	
22-23.99	23	5	1	5	5
24-25.99	25	3	2	6	12
26-27.99	27	2	3	6	18
28-29.99	29	1	4	4	16
30-31.99	31	3	5	15	75
32-33.99	33		6		
34-35.99	35	2	7	14	98
36-37.99	37	1	8	8	64
38-39.99	39	1	9	9	81
		43		67	603

Range = 39-8 = 31

Standard Deviation = 7.42

Mean = 21 - $\frac{7x2}{43}$ = 21.32 P.E. of the Mean = $\pm .763$

Difference between the Means = 21.23-18.74 = 2.49

Probable Error of the Means = ± 1.10

Critical Ratio = 2.26

Comparison of boys' and girls' scores (continued)

These figures would indicate a slight superiority in favor of the Grade 8 boys in Science vocabulary but nothing significant. This is more the finding that one would expect in the vocabulary test since girls are usually superior to boys in this field.

It may be that this part of the Junior High School Course appeals more to girls than the other sections do. The Grade 8 course in Calgary comprises - Astronomy, Weather, Hard and Soft Water, Soaps, etc.

TABLE XIII

Comparison of boys' and girls' scores (continued)

Grade 8 Girls - Test 11

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
6-7.99	7	1	-7	-7	49
8-9.99	9	3	-6	-18	108
10-11.99	11	2	-5	-10	50
12-13.99	13	3	-4	-12	48
14-15.99	15	6	-3	-18	54
16-17.99	17	8	-2	-16	32
18-19.99	19	6	-1	-6	6
20-21.99	21	6	0	-87	
22-23.99	23	5	1	5	5
24-25.99	25	5	2	10	20
26-27.99	27	3	3	9	27
28-29.99	29	1	4	4	16
30-31.99	31	4	5	20	100
32-33.99	33	2	6	12	72
34-35.99	35	2	7	14	98
36-37.99	37		8		
38-39.99	39	1	9	9	81
		58		83	766

Range = 38-6 = 32

Standard Deviation = 7.26

Mean = $21 - \frac{4x2}{58} = 20.86$ P.E. of the Mean = $\pm .643$

Grade 8 Boys - Test 11

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
4-5.99	5	1	-10	-10	100
6-7.99	7		-9		
8-9.99	9		-8		
10-11.99	11		-7		
12-13.99	13	1	-6	-6	36
14-15.99	15		-5		
16-17.99	17	5	-4	-20	80
18-19.99	19	2	-3	-6	18
20-21.99	21	4	-2	-8	16
22-23.99	23	5	-1	-5	
24-25.99	25	3	0	-55	
26-27.99	27	5	1	5	5
28-29.99	29	6	2	12	24
30-31.99	31	8	3	24	72
32-33.99	33	3	4	12	48
34-35.99	35		5		
36-37.99	37		6		
38-39.99	39		7		
40-41.99	41		8		
42-43.99	43	1	9	9	81
		43		62	485

Range = 42-4 = 38

Standard Deviation = 7.10

Mean = $25 - \frac{7x2}{43} = 25.32$ P.E. of the Mean = $\pm .731$ Difference between the Means = $25.32 - 20.86 = 4.46$

Probable Error of the Means = .969

Critical Ratio = 4.6

Comparison of boys' and girls' scores (continued)

Test 11 shows a real superiority in favor of the Grade 8 boys. Apparently their factual knowledge in Science is quite beyond that of the girls. Comparing the Grade 8 and Grade 9 Means on this Test we see that the boys are approximately eight months ahead of the girls.

TABLE XIV

Comparison of boys' and girls' scores (continued)

Grade 8 Girls - Test III

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
8-9.99	9	2	-4	-8	32
10-11.99	11	2	-3	-6	18
12-13.99	13	7	-2	-14	28
14-15.99	15	9	-1	-9	9
16-17.99	17	12	0	<u>-37</u>	
18-19.99	19	11	1	11	11
20-21.99	21	6	2	12	24
22-23.99	23	5	3	15	45
24-25.99	25	3	4	12	48
26-27.99	27	1	5	5	25
		<u>58</u>		<u>55</u>	<u>240</u>

Range = 26-8 = 18 Standard Deviation = ± 3.88

Mean = $17 + \frac{18 \times 2}{58} = 17.62$ P.E. of the Mean = $\pm .343$

Grade 8 Boys - Test III

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
6-7.99	7	1	-7	-7	49
8-9.99	9		-6		
10-11.99	11		-5		
12-13.99	13	1	-4	-4	16
14-15.99	15	3	-3	-9	27
16-17.99	17	7	-2	-14	28
18-19.99	19	6	-1	-6	6
20-21.99	21	10	0	-40	
22-23.99	23	7	1	7	7
24-25.99	25	2	2	4	8
26-27.99	27	3	3	9	27
28-29.99	29	2	4	8	32
30-31.99	31		5		
32-33.99	33		6		
34-35.99	35	<u>1</u>	7	<u>7</u>	<u>49</u>
		<u>43</u>		<u>35</u>	<u>249</u>

Range = 35-6 = 29 Standard Deviation = 4.74

Mean = $21 - \frac{5 \times 2}{43} = 20.77$ P.E. of the Mean = $\pm .487$

Difference between the Means = $20.77 - 17.62 = 3.15$

Probable Error of the Means = $\pm .594$

Critical Ratio = 5.30

This test of Scientific Principles shows the Grade 8 boys about six months ahead of the Grade 8 girls. As in Grade 7 the difference is not as great as on Test II.

TABLE XV

Comparison of Boys' and girls' scores (continued)

Grade 8 Girls - Test IV

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
8-9.99	9	1	-6	-6	36
10-11.99	11	2	-5	-10	50
12-13.99	13	7	-4	-28	56
14-15.99	15	8	-3	-24	72
16-17.99	17	7	-2	-14	28
18-19.99	19	6	-1	-6	6
20-21.99	21	5	0	-88	
22-23.99	23	8	1	8	8
24-25.99	25	6	2	12	24
26-27.99	27	2	3	6	18
28-29.99	29	3	4	12	48
30-31.99	31	1	5	5	25
32-33.99	33	1	6	6	36
34-35.99	35	1	7	7	49
		<u>58</u>		<u>56</u>	<u>457</u>

Range = 34-7 = 27

Standard Deviation = 5.16

Mean = 21 - $\frac{32 \times 2}{58}$ = 19.90 P.E. of the Mean = $\pm .460$

Grade 8 Boys - Test IV

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
8-9.99	9	4	-6	-24	144
10-11.99	11	2	-5	-10	50
12-13.99	13	2	-4	-8	32
14-15.99	15	5	-3	-15	45
16-17.99	17	1	-2	-2	4
18-19.99	19	3	-1	-3	3
20-21.99	21	6	0	-62	
22-23.99	23	3	1	3	3
24-25.99	25	7	2	14	28
26-27.99	27	7	3	21	63
28-29.99	29		4		
30-31.99	31	3	5	15	75
		<u>43</u>		<u>53</u>	<u>447</u>

Range = 30-7 = 23

Standard Deviation = 6.39

Mean = 21 - $\frac{9 \times 2}{43}$ = 20.58 P.E. of the Mean = $\pm .657$

Difference between the Means = 20.58-19.90 = .68

Probable Error of the Means = $\pm .81$

Critical Ratio = .84

These results show that there is no real difference in the performance of Grade 8 boys and girls on Test IV. These check with Grade 7 results also. It seems that girls are as capable as boys at puzzling their way through problems,

Comparison of Boys' and Girls' scores (continued)

the answers to which they have not learned. This of course is what we would expect.

TABLE XVI

Comparison of boys' and girls' scores (continued)

Grade 9 Girls - Test 1

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
8-9.99	9	1	-7	-7	49
10-11.99	11	1	-6	-6	36
12-13.99	13	3	-5	-15	75
14-15.99	15	3	-4	-12	48
16-17.99	17	6	-3	-18	54
18-19.99	19	3	-2	-6	12
20-21.99	21	5	-1	-5	5
22-23.99	23	7	0	-69	
24-25.99	25	11	1	11	11
26-27.99	27	7	2	14	28
28-29.99	29	6	3	18	54
30-31.99	31	4	4	16	64
32-33.99	33	5	5	25	125
34-35.99	35	2	6	12	72
36-37.99	37		7		
38-39.99	39	1	8	8	64
40-41.99	41		9		
42-43.99	43	1	10	10	100
		66		114	797

Range = 43-9 = 34

Standard Deviation = 6.4

Mean = $23 \neq \frac{45 \times 2}{66} = 24.34$ P.E. of the Mean = $\pm .530$

Grade 9 Boys - Test 1

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
10-11.99	11	1	-10	-10	100
12-13.99	13		-9		
14-15.99	15		-8		
16-17.99	17		-7		
18-19.99	19	1	-6	-6	36
20-21.99	21	4	-5	-20	100
22-23.99	23	4	-4	-16	64
24-25.99	25	4	-3	-12	36
26-27.99	27	3	-2	-6	12
28-29.99	29	5	-1	-5	5
30-31.99	31	8	0	0	
32-33.99	33	5	1	5	5
34-35.99	35	8	2	16	32
36-37.99	37	3	3	9	27
38-39.99	39	1	4	4	16
40-41.99	41	6	5	30	150
42-43.99	43	2	6	12	72
		55		76	655

Range = 42-10 = 32

Standard Deviation = 6.90

Mean = $31 \neq \frac{1 \times 2}{55} = 31.02$ P.E. of the Mean = $\pm .627$ Difference between the Means = $31.02 - 24.34 = 6.68$ Probable Error of the Means = $\pm .820$

Critical Ratio = 8.14

Comparison of boys' and girls' scores (continued)

The Grade 9 boys show a real superiority over the girls in Science Vocabulary. This is in line with the Grade 7 results but not with the Grade 8 ones. However the Grade 9 course seems more designed to appeal to boys so this may account for the difference. For example, in Grade 9 we study Machines, Heat, Magnetism, Electricity, etc.,

TABLE XVII

Comparison of boys' and girls' scores (continued)

Grade 9 Girls - Test 11

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
10-11.99	11	1	-7	-7	49
12-13.99	13	3	-6	-18	108
14-15.99	15	3	-5	-15	75
16-17.99	17	2	-4	-8	32
18-19.99	19	7	-3	-21	63
20-21.99	21	8	-2	-16	32
22-23.99	23	5	-1	-5	5
24-25.99	25	10	0	-90	
26-27.99	27	5	1	5	5
28-29.99	29	4	2	8	16
30-31.99	31	5	3	15	45
32-33.99	33	5	4	20	80
34-35.99	35	4	5	20	100
36-37.99	37		6		
38-39.99	39	2	7	14	98
40-41.99	41	2	8	16	128
		66		98	836

Range = 40-10 = 30

Standard Deviation = 7.10

Mean = 25 \neq $\frac{8x_2}{66} = 25.24$ P.E. of the Mean = $\pm .589$

Grade 9 Boys - Test 11

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
10-11.99	11	2	-11	-22	242
12-13.99	13		-10		
14-15.99	15		-9		
16-17.99	17	1	-8	-8	64
18-19.99	19		-7		
20-21.99	21	2	-6	-12	72
22-23.99	23	2	-5	-10	50
24-25.99	25	3	-4	-12	48
26-27.99	27	3	-3	-9	27
28-29.99	29	2	-2	-4	8
30-31.99	31	5	-1	-5	5
32-33.99	33	10	0	82	
34-35.99	35	8	1	8	8
36-37.99	37	7	2	14	28
38-39.99	39	3	3	9	27
40-41.99	41	4	4	16	64
42-43.99	43	2	5	10	50
44-45.99	45	1	6	6	36
		55		63	729

Range = 44-10 = 34

Standard Deviation = 7.22

Mean = 33 - $\frac{19x_2}{55} = 32.31$ P.E. of the Mean = $\pm .656$

Difference between the Means = 32.31-25.24 = 7.07

Probable Error of the Means = $\pm .881$

Critical Ratio = 8.02

Comparison of boys' and girls' scores (continued)

Here again is a significant difference between boys and girls showing that the girls as a rule are retarded in Science compared with the boys. I would suggest this to be a retardation of about one year but have no Grade 10 scores to prove my point.

TABLE XVIII

Comparison of boys' and girls' scores (continued)

Grade 9 Girls - Test III

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
10-11.99	11	3	-6	-18	108
12-13.99	13	3	-5	-15	75
14-15.99	15	7	-4	-28	112
16-17.99	17	1	-3	-3	9
18-19.99	19	5	-2	-10	20
20-21.99	21	16	-1	-16	16
22-23.99	23	7	0	-90	
24-25.99	25	4	1	4	4
26-27.99	27	6	2	12	24
28-29.99	29	4	3	12	36
30-31.99	31	5	4	20	80
32-33.99	33	2	5	10	50
34-35.99	35	3	6	18	108
		<u>66</u>		<u>76</u>	<u>642</u>

Range = 35-11 = 24

Standard Deviation = 6.18

Mean = 23 - $\frac{14x2}{66}$ = 22.58 P.E. of the Mean = $\pm .513$

Grade 9 Boys - Test III

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
18-19.99	19	1	-5	-5	25
20-21.99	21	1	-4	-4	16
22-23.99	23	10	-3	-30	90
24-25.99	25	2	-2	-4	8
26-27.99	27	8	-1	-8	8
28-29.99	29	7	0	-51	
30-31.99	31	6	1	6	6
32-33.99	33	8	2	16	32
34-35.99	35	5	3	15	45
36-37.99	37	5	4	20	80
38-39.99	39		5		
40-41.99	41	2	6	12	69
		<u>55</u>			<u>382</u>

Range = 41-19 = 22

Standard Deviation = 5.10

Mean = 29 - $\frac{18x2}{55}$ = 29.65 P.E. of the Mean = $\pm .463$

Difference between the Means = 29.65-22.58 = 7.07

Probable Error of the Means = $\pm .697$

Critical Ratio = 10.14

Here is the greatest difference yet encountered. It would appear that the Grade 9 boys are rapidly gaining in power to see the application of scientific principles to ordinary problems while the girls have not yet reached that stage. It is rather interesting that this is the only Grade

'Comparison of boys' and girls' scores (continued)

in which a great variation is shown between boys and girls on Test III.

TABLE XIX

Comparison of boys' and girls' scores (continued)

Grade 9 Girls - Test IV

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
6-7.99	7	1	-8	-8	64
8-9.99	9		-7		
10-11.99	11	3	-6	-18	108
12-13.99	13	2	-5	-10	50
14-15.99	15	3	-4	-12	48
16-17.99	17	2	-3	-12	36
18-19.99	19	6	-2	-12	24
20-21.99	21	7	-1	-7	7
22-23.99	23	11	0	-79	
24-25.99	25	11	1	11	11
26-27.99	27	9	2	18	36
28-29.99	29	6	3	18	54
30-31.99	31	2	4	8	32
32-33.99	33	2	5	10	50
34-35.99	35	1	6	6	36
		66		71	556

Range = 35-7 = 28

Standard Deviation = 5.78

Mean = $23 - \frac{8x2}{66} = 22.76$ P.E. of the Mean = $\pm .480$

Grade 9 Boys - Test IV

Class Interval	Midpoint	Frequency f	Deviation d	Product fd	fd ²
10-11.99	11	1	-7	-7	49
12-13.99	13		-6		
14-15.99	15	5	-5	-25	125
16-17.99	17	2	-4	-8	32
18-19.99	19	2	-3	-6	18
20-21.99	21	5	-2	-10	20
22-23.99	23	9	-1	-9	9
24-25.99	25	8	0	-65	
26-27.99	27	11	1	11	11
28-29.99	29	10	2	20	40
30-31.99	31	1	3	3	9
32-33.99	33	1	4	4	16
		55		38	329

Range = 33-11 = 22

Standard Deviation = 4.91

Mean = $25 - \frac{27x2}{55} = 24.02$ P.E. of the Mean = $\pm .447$

Difference between the Means = $24.02 - 22.76 = 1.26$

Probable Error of the Means = $\pm .655$

Critical Ratio = 1.93

Once again the former statements are borne out that in generalization and reflective thinking there is no significant difference between boys and girls even in the field of science.

C

How does science attainment in each and all of the fields tested compare with the science achievement in regular school work?

An attempt was made to answer this question by correlating each Test given in grade 8 and 9 with their school average and finally correlating the total score made on all four Tests with their School average. As previously stated, it was not felt advisable to do the same for the grade 7's since no reliable mark had as yet been arrived at for their school average.

The correlation charts with their synopsis follows and the reader can form his own opinion as to their meaning, although a few suggestions have been put forward. In this work the correlation method as outlined by Greene and Jorgensen has been employed because of its simplicity.

TABLE XX

Correlation of Grade 9 School Achievement in Science and Score on Test I (Science Vocabulary)

		School Achievement - X																							
		40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	f	fd	fd ²	
		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	-8	-24	
10		1																				3	-7	-21	
12			1																			3	-6	-18	
14				1																		3	-5	-30	
16					1																	6	-4	-16	
18						1																4	-3	-27	
20							1															9	-3	-27	
22								1														11	-2	-22	
24									1													14	-1	-14	
26										1												10	0	-172	
28											1											12	1	12	
30												1										12	2	24	
32													1									9	3	27	
34														1								11	4	44	
36															1							11	4	44	
38																1						6	5	20	
40																	2					7	7	49	
42																		2				3	8	24	
f																			2			1	1	1	
d																						121			
fd																									
fd ²																									
Test																									
Scores																									

$$c_x = \frac{156 - 172}{121} = -.133$$

$$c_y = \frac{200 - 176}{121} = .199$$

$$r = \frac{\frac{XY}{N} - c_x c_y}{\frac{\text{St.Dev.} \times \text{St.Dev.} \cdot y}{N}}$$

$$\text{Standard Deviation}_x = \sqrt{\frac{1458}{121}} = 3.47$$

$$\text{Standard Deviation}_y = \sqrt{\frac{1784}{121}} = 3.84$$

$$r = \frac{\frac{1021}{121} - .026}{\frac{3.47 \times 3.84}{121}} = +.626$$

TABLE XXI

Correlation of Grade 9 School Achievement in Science and Score on Test II (Scientific Facts)

		School Achievement - X																									
		40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	f	d	fd	fd ²	XY	135
		10																			3	-9	-27	243	192	96	
		12	1	1	1	1	1	1	1	1	2	2	2	2	1	1	1	1	2	2	3	-8	-24	147	140	66	
		14																			3	-7	-21	108	108	66	
		16																			3	-6	-18	175	175	140	
		18	1																		7	-5	-35	144	144	176	
		20																			9	-4	-36	81	81	48	
		22																			9	-3	-27	56	56	8	
		24																			14	-2	-28	8	8	6	
		26																			8	-1	-8	6	6	6	
		28																			6	0	-224	11	11	9	
		30																			11	1	11	26	52	32	
		32																			13	2	3	36	108	30	
		34																			12	3	4	28	112	64	
		36																			7	4	5	20	100	65	
		38																			4	6	6	36	216	126	
		40																			6	6	7	14	98	63	
		42																			2	2	2	7	8	56	
		44																			1	1	1	1	1	1	
		f	2	2	3	2	3	2	3	2	3	7	3	7	13	9	15	18	12	11	8	6	2	1	121	179	
		d	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7							
		fd	-20	-16	-21	-12	-35	-12	-21	-26	-9	-172	18	24	33	32	30	12	7	7	156						
		fd ²	200	128	147	72	175	48	63	52	9	18	48	99	128	150	72	49	1458								

$$c_x = -.133$$

$$\text{Standard Deviation}_x = 3.47 \quad \text{Standard Deviation}_y = 3.97$$

$$r = +.693$$

$$c_y = -.372$$

TABLE XXII

Correlation of Grade 9 School Achievement in Science and Score on Test III (Scientific Principles)

		School Achievement										\bar{X}														
		40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	f	d	fd	fd^2	ΣY
		1	1	1	1	1	1	1	2	1	1	2	1	4	1	2	3	2	3	1	1	1	1	1	1	1
X		10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58
Y		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
d		2	0	-2	-4	-6	-8	-10	-12	-14	-16	-18	-20	-22	-24	-26	-28	-30	-32	-34	-36	-38	-40	-42	-44	-46
fd		2	0	-2	-4	-6	-8	-10	-12	-14	-16	-18	-20	-22	-24	-26	-28	-30	-32	-34	-36	-38	-40	-42	-44	-46
fd^2		4	0	-4	-12	-24	-36	-52	-72	-92	-112	-132	-152	-172	-192	-212	-232	-252	-272	-292	-312	-332	-352	-372	-392	-412
Σd		2	0	-2	-4	-6	-8	-10	-12	-14	-16	-18	-20	-22	-24	-26	-28	-30	-32	-34	-36	-38	-40	-42	-44	-46
Σfd		2	0	-2	-4	-6	-8	-10	-12	-14	-16	-18	-20	-22	-24	-26	-28	-30	-32	-34	-36	-38	-40	-42	-44	-46
Σfd^2		4	0	-4	-12	-24	-36	-52	-72	-92	-112	-132	-152	-172	-192	-212	-232	-252	-272	-292	-312	-332	-352	-372	-392	-412
ΣY		121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121

$$c_x = -.133$$

$$\text{Standard Deviation}_x = 3.47 \quad \text{Standard Deviation}_y = 3.37$$

$$r = +.708$$

$$c_y = .330$$

TABLE XXIII

Correlation of Grade 9 School Achievement in Science and Score on Test IV (Scientific Attitudes)

		School Achievement - X																								
		40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	f	d	fd	fd ²	XY
		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Y		8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56
Scores Test IV		1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
f		2	2	3	2	7	3	7	13	9	15	18	12	11	8	6	2	1	121	121	121	121	121	121	121	121
d		-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	7	7	7	7	7	7	7
fd		-20	-16	-16	-21	-12	-35	-12	-21	-26	-9	-172	18	24	35	32	30	128	150	72	49	49	49	49	49	49
fd ²		200	128	147	72	175	48	63	52	9	18	48	99	128	150	150	150	150	150	150	150	150	150	150	150	150

$$c_x = -.133$$

$$c_y = .133$$

$$\text{Standard Deviation}_x = 3.47$$

$$\text{Standard Deviation}_y = 2.69$$

$$r = +.477$$

TABLE XXIV

Correlation of Grade 9 School Achievement in Science and Total of Test Scores

		School Achievement - X																								
		40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	f	fd	fd ²	XY	
		50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	f	fd	fd ²	XY			
Y		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
- X		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Total of Test Scores		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
f		2	2	3	2	7	3	7	13	9	15	18	12	11	8	6	2	1	1	1	1	1	1	1	1	
d		-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	7	7	7	7	7	7	
fd		-20	-16	-16	-21	-12	-35	-12	-21	-26	-9	-172	18	24	33	32	30	12	12	12	12	12	12	12	12	12
fd ²		200	128	147	72	175	48	63	52	9	18	48	99	128	150	72	49	49	49	49	49	49	49	49	49	49

$$c_x = -.207$$

Standard Deviation_x = 3.43 Standard Deviation_y = 4.45

$$r = .815$$

$$c_y = .128$$

TABLE XXXV

Correlation of Grade 8 School Achievement in Science and Score on Test I (Science Vocabulary)

School Achievement - X																						
47½	50	52½	55	57½	60	62½	65	67½	70	72½	75	77½	80	82½	85	87½	90	92½	95	97½	100	102½
2½																						
5	2	1																				
7½	1	2																				
10	1	1	2																			
12½				1																		
15	1				1																	
X																						
-																						
20																						
22½																						
25																						
27½																						
30																						
32½																						
35																						
37½																						
Scores	1																					
f	2	7	4	3	3	7	6	7	4	13	4	10	4	6	3	5	2	8	2	= 101		
d	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
fd	-13	-18	-56	-28	-18	-15	-28	-18	-14	-4	-212	4	20	12	24	15	30	14	64	18	= 203	
fd ²	169	162	448	196	108	75	112	54	28	4	40	36	96	75	180	98	512	162	= 2559			

$$c_x = -.09$$

$$c_y = .367$$

$$\text{Standard Deviation}_x = 5.03$$

$$\text{Standard Deviation}_y = .3.42$$

$$r = .700$$

TABLE XXVI

Correlation of Grade 8 School Achievement in Science and Score on Test II (Scientific Facts)

$$c_V = .630$$

$$c_X = -.09$$

$$\text{Standard Deviation}_X = 5.03 \quad \text{Standard Deviation}_Y = 3.00$$

1963 = 11

TABLE XXVII

Correlation of Grade 8 School Achievement in Science and Score on Test III (Scientific Principles)

$$c_x = -1$$

$$c_v = -0.020$$

$$\text{Standard Deviation}_X = 5.03 \quad \text{Standard Deviation}_Y = 2.32$$

$$\pi = +.696$$

Correlation of Grade 8 School Achievement in Science and Score on Test IV (Scientific Attitudes)

$$C_A = -0.455$$

$$S_{\text{standard Deviation}_X} = 5.03 \quad \text{Standard Deviation} = 3.11$$

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TABLE XXIX

Correlation of Grade 8 School Achievement in Science and Total of Test Scores

		Total of Test Scores - X																											
		35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	f	d	fd	fd ²	XY	
		40																						1	-7	-7	49	56	
		45	1																						-6	-5	-10	50	45
		50																							2	-5	-10	50	45
		55																							11	-4	-44	176	204
		60																							6	-3	-18	54	63
		65																							13	-2	-26	52	60
		70																							11	-1	-11	11	-4
		75																							17	0	-116		
		80																							14	1	14	30	
		85																							8	2	16	32	58
		90																							3	24	72	138	
		95																							8	10	40	160	304
		100																							1	10	4		
		105																							1	101	94	670	954
		f	1	4	4	4	8	4	14	9	6	6	6	6	4	9	2	4	2	1	1	101							
		d	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13					
		fd	-8	-28	-24	-20	-32	-12	-28	-9	-161	6	12	18	24	20	54	14	32	18	10	13	13	13	-221				
		fd ²	64	196	144	100	128	36	56	9	6	24	54	96	100	324	98	256	162	100	169	2122							
		ScHooL AChievement - Y																											

$$c_x = .594$$

$$c_y = -.218$$

Standard Deviation_x = 4.59

Standard Deviation_y = 2.57

$$r = +.801$$

TABLE XXX

Synopsis of Correlations

	Grade 9 r=	Grade 8 r=
Test I and School Ach.	+.626	+.700
Test II and School Ach.	+.693	+.763
Test III and School Ach.	+.708	+.696
Test IV and School Ach.	+.477	+.622
Total Test Scores and School Ach.	+.815	+.801

A study of Table XXX will show a few interesting and important relationships. To begin with, all of the correlations being positive would lead us to believe that all of these four fields are taken into account when arriving at an average mark for any child. Since the Test on scientific or reflective thinking shows the lowest correlation with the school average this would lead us to believe that this field is the most neglected in assessing a pupil's standing in science in regular school work. It would appear from these figures that there is a real relationship between a student's science vocabulary, his factual knowledge in science, and his ability to see and apply scientific principles and his progress in school in this subject. However, when all four Tests are totalled and correlated with the school average a marked relationship of real significance is obtained, since a correlation of above $.8$ is unusual in such work according to Green and Jorgensen. Finally, it would appear that these four Tests could be used, with reasonably good results, to place a child in science who had come from some other school, Province, or Country and who was not doing acceptable work in the grade in which he had been placed.

CHAPTER V

CONCLUSIONS AND SUGGESTIONS

As a result of this investigation one might reasonably come to certain conclusions which might be helpful to others working on a similar project or teaching science in the Junior High School.

1 In order that a child may progress satisfactorily in science through the Junior High School it would appear that each of the three fields: science vocabulary, science facts and science principles, should be given time, thought and stress.

2 There appears to be a tremendous variation in all fields tested among pupils of even the same grade.

3 In grade 7 the boys appear to be about four months ahead of the girls in science while by the time they reach grade 9 they appear to be about eight or nine months ahead of them, which would lead one to believe that boys not only have a better grasp of science in the first place but also progress more rapidly.

4 There seems to be a somewhat steady growth through these grades in the field of science except in that field of scientific thinking.

5 Since there is very little development in scientific thinking it would appear that this is something which is not learned or taught but rather that it develops as a result of maturation.

6 By administering these four Tests to any child who is not progressing satisfactorily in science a teacher could get a fairly reliable measure of that child's ability in each and all of those fields tested and could also get a reasonable idea for remedial work.

Suggestions:

1 Similarly one might pass on a few suggestions to

others interested in this type of work:

1 One might capitalize upon the idea of such great variation among pupils and allow those who are up to standard in any field of science to go on with science work in which they are especially interested while the others are doing the more tedious and routine work of learning fundamentals.

2 The girls appear to require more attention in science than do the boys and hence more individual assistance, as well as more questions, which is probably one place wherein most teachers fall short.

3 From the results of this investigation it would appear that equal stress should be placed on each of the three fields tested: viz., vocabulary, facts, and principles. It would seem that the vocabulary is apt to be overlooked in the endeavor to teach facts and principles.

General Suggestions:

1 It would seem, upon later thought and study, that Test III should have been more objective in nature. Also that in Test IV probably question 5 should have been replaced by one which called for a little more generalized thinking, rather than the drawing of conclusions, which was tested in Test III.

2 These results would also make one wonder whether the Grade 9 Science Examinations as set by the Department are of the best type for that grade level. During the past few years it would appear that these tests call for reflective or scientific thinking to quite an extent but according to this investigation this is not a fair test of their growth during the Junior High School years.

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